# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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# RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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# Pathways of Cerebral Collateral Circulation[1]

MAURICE TATELMAN, M.D.[2]

DESPITE CONSIDERABLE anatomical proof to the contrary, the myth of "end-artery" circulation to the brain has been perpetuated in textbooks for years. This interpretation of Cohnheim's original theory concerning infarction and his concept of end-arteries, published in 1872, has led to the erroneous assumption that cerebral collateral circulation is sparse and inefficient, if not actually nonexistent (1). The presence of a cerebral collateral circulation and its significance have become especially evident with our continuing angiographic evaluation of patients with stroke syndromes during the past three years (2). Our studies have prompted an evaluation of the importance of collateral circulation in these and other cases and an investigation of the pathways by which this occurs, as demonstrated on the cerebral angiogram.

## NORMAL CEREBRAL BLOOD FLOW

As far back as 1912, Kramer (3) demonstrated by means of dye injection in living animals that each internal carotid artery normally supplies blood only to the distribution of its anterior and middle cerebral branches, and the vertebral arteries, *via* the basilar, only to the distribution of the cerebellar and posterior cerebral branches. This was confirmed by vascular injection studies in the human cadaver by Fay in 1925 (4). In 1948 Shenkin *et al.* (5) corroborated these observations in man by injecting Evans blue into the internal carotid arteries and recovering the dye from the internal jugular vein on the injected side only.

These concepts are borne out by everyday experience with normal internal carotid and vertebral arteriograms. Thus, it is seen that the circle of Willis acts as a shunt mechanism and does not, under normal circumstances, allow mixing of blood coming from each of the two internal carotid arteries and the basilar artery (6).

Not uncommonly on internal carotid arteriography filling of the posterior cerebral artery is observed. This may be because the posterior cerebral artery originates as a branch of the internal carotid and not of the basilar artery. Such an origin was reported by Riggs and Griffiths as occurring in approximately 26 per cent of autopsies on persons with nervous and mental disorders (7) although Fawcett and Blackford found it in less than 2 per cent of autopsies (8). Despite statements that filling of the posterior cerebral artery may be seen in carotid arteriography in 15 to 25 per cent of cases, an evaluation of 564 normal carotid arteriograms showed, in our hands, posterior cerebral artery filling on one or both sides in only 11.5 per cent (Table I).

Collateral filling of the opposite anterior

[1] From the Departments of Radiology, Wayne State University College of Medicine, Detroit Receiving Hospital, and Detroit Memorial Hospital, Detroit, Mich. Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

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TABLE I: NORMAL FILLING OF THE POSTERIOR CEREBRAL ARTERY ON CAROTID ARTERIOGRAPHY

| Carotid Arteriography | Cases | Posterior Cerebral Filling Cases |
|---|---|---|
| Unilateral injection | 164 | 14 (8.5%) |
| Bilateral injection | 200 | 28 (14.0%) |
| Post. cerebral filling from both | | 13 (6.5%) |
| Post. cerebral filling from one | | 15 (7.5%) |
| TOTAL | 364 | 42 (11.5%) |

cerebral artery on internal carotid arteriography is also generally considered a normal phenomenon. However, a study of 1,083 normal carotid angiograms does not seem to bear out this contention. Table II shows that, when only one internal carotid artery was studied, cross-filling of the contralateral anterior cerebral artery occured in 10.5 per cent of cases; whereas, when both carotids were evaluated, contralateral filling was evident in only 2.5 per cent from both sides and in only 5.5 per cent from one side. It would seem probable, therefore, that in many of the cases in which only one internal carotid artery was evaluated, some disease or anomaly on the opposite side might prove to be the cause of the higher percentage of collateral anterior cerebral filling. Thus, many of these cases would have been thrown out of the "normal" series (Fig. 1).

TABLE II: NORMAL FILLING OF CONTRALATERAL ANTERIOR CEREBRAL ARTERY ON CAROTID ARTERIOGRAPHY

| Carotid Arteriography | Cases | Contralateral Anterior Cerebral Filling Cases |
|---|---|---|
| Unilateral injection | 389 | 41 (10.5%) |
| Bilateral injection | 347 | |
| Contralateral anterior cerebral filling, one side only | | 19 (5.5%) |
| Contralateral anterior cerebral filling, both sides | | 9 (2.5%) |
| TOTAL | 736 | 69 (9.3%) |

## CAUSES OF CEREBRAL COLLATERAL CIRCULATION

The question arises: What causes such collateral blood flow, *i.e.*, reversal of normal direction of flow? Normal flow is dependent on the head of pressure in the supplying vessels and the resistance to blood flow peripherally. Thus, any process which narrows or dilates the lumen of a vessel, either peripherally or centrally, may change the local arterial pressure and lead to collateral blood flow. Various conditions in which such changes occur and in which collateral circulation has been seen are:

A. Narrowing of vessel lumen
   1. Atherosclerosis—plaque or thrombus
   2. Embolus
   3. Congenital stenosis or atresia
   4. Surgical ligation
   5. Compression of artery extracranially
      (*a*) Mass in neck or mediastinum
      (*b*) Arthritic spur
      (*c*) Digital or collar compression
   6. Intracranial mass

B. Dilatation of vessel lumen
   1. Arteriosclerosis
   2. Localized vasodilator effects?

C. Vascular shunts
   1. Carotid-cavernous fistula
   2. Arteriovenous malformation

As might be expected, atherosclerotic narrowing or occlusion was the most common cause of collateral blood flow seen on cerebral angiography in our series (Table III). In general, some form of collateral circulation was seen in 61.7 per cent of our 191 cases of complete or partial occlusion of the cerebral vessels. The range for the various sites of occlusive disease was from 10.5 to 84.6 per cent, with 60 per cent or over for most sites and around 80 per cent for many. These percentages would probably be even higher if vertebral as well as bilateral carotid ar-

TABLE III: COLLATERAL CIRCULATION IN OCCLUSIVE CEREBRAL VASCULAR DISEASE

| Type of Occlusion | Cases | Collateral Circulation Shown Cases |
|---|---|---|
| Complete internal carotid | 46 | 27 (58.7%) |
| Partial internal carotid | 29 | 11 (38.0%) |
| Complete vertebral basilar | 8 | 5 (62.5%) |
| Partial vertebral basilar | 10 | 6 (60.0%) |
| Complete anterior cerebral | 37 | 29 (78.4%) |
| Small anterior cerebral | 26 | 22 (84.6%) |
| Partial anterior cerebral | 11 | 9 (81.8%) |
| Complete middle cerebral | 19 | 2 (10.5%) |
| Partial middle cerebral | 5 | 1 (20.0%) |
| TOTAL | 191 | 118 (61.7%) |

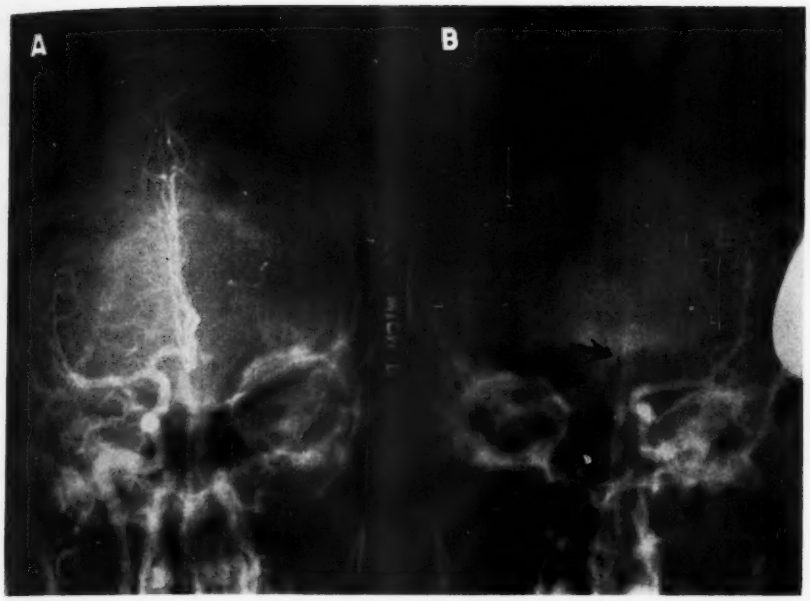


Fig. 1. Unilateral small anterior cerebral artery with collateral blood flow from opposite carotid artery.

A. Right carotid arteriogram: filling of both anterior cerebral arteries through the anterior communicating artery.

B. Left carotid arteriogram: very small left anterior cerebral artery which does not fill beyond the point of the anterior communicating artery (arrow).

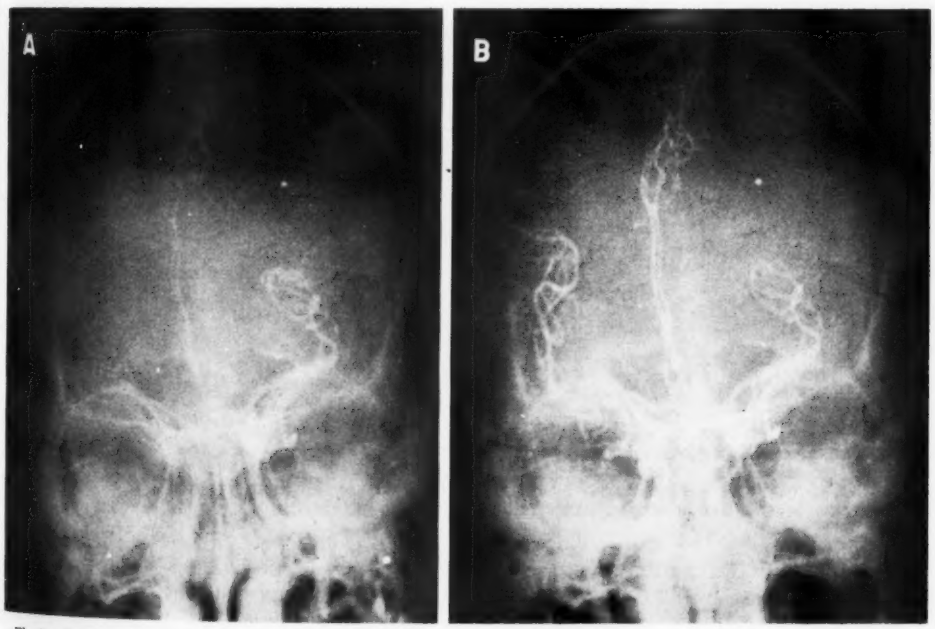


Fig. 2. Subdural hematoma with collateral circulation.

A. Left carotid arteriogram: shift of anterior cerebral group to right and marked inward displacement of middle cerebral group characteristic of subdural hematoma. Note parietal skull fracture on left.

B. Right carotid arteriogram: collateral filling of all vessels on left because of increased peripheral vascular resistance on the left due to pressure of the mass and possibly cerebral edema as well.

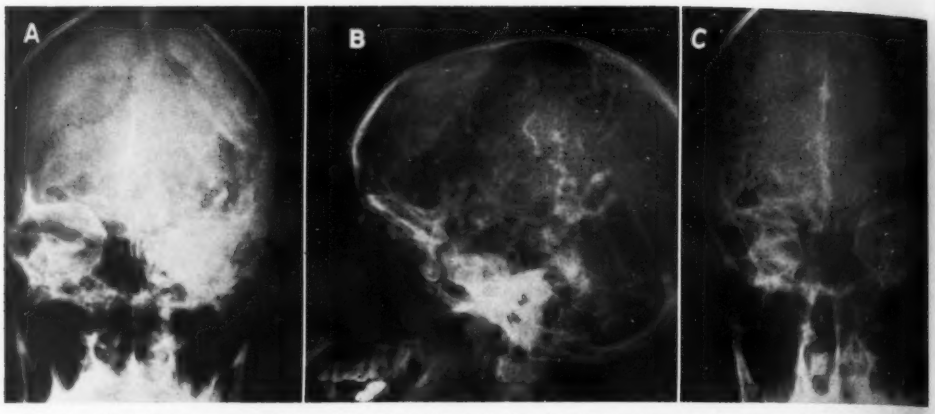


Fig. 3. Carotid-cavernous fistula with collateral circulation (studies performed three years following injury).
A and B. Left carotid arteriogram: opacification of cavernous sinus with marked retrograde filling of dilated intracerebral veins but with no filling of the arteries beyond the carotid siphon. Note the dilatation of the intracranial portion of the internal carotid artery.
C. Right carotid arteriogram: good collateral filling of all branches on the left, including some retrograde filling of the internal carotid for a short distance proximal to its bifurcation (distal to the carotid-cavernous fistula).

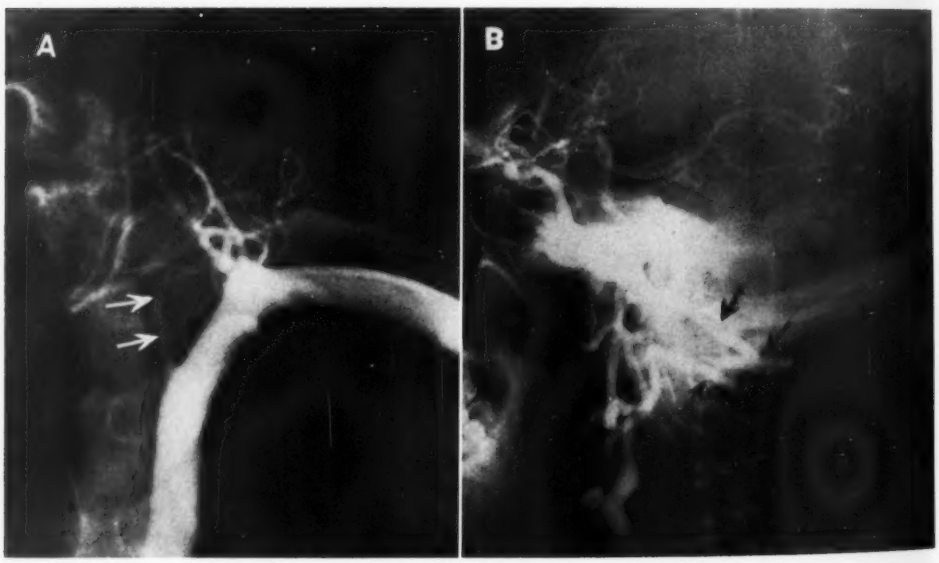


Fig. 4. Stenosis or atresia of part of vertebral artery (congenital?) with collateral circulation.
A. Left vertebral arteriogram by retrograde brachial catheterization: small segment of vertebral artery with complete stenosis or atresia at the upper arrow.
B. Left carotid arteriogram: markedly dilated occipital artery (lower arrow) arising from external carotid supplying good collateral flow to the dilated distal portion of the vertebral artery (upper arrows).

teriography had been employed in every instance.

The low incidence of collateral circulation seen in partial internal carotid occlusion is easily explained, since in every such ease, even in the presence of severe narrowing, good filling of the intracranial branches was obtained, suggesting lack of sufficient pressure differential to bring on collateral circulation. The even lower incidence of collateral circulation in middle cerebral artery occlusion is due to

Fig. 5. Atherosclerosis of proximal vertebral artery. Vertebral angiogram by retrograde brachial artery catheterization in patient with normal bilateral carotid arteriography (except for retrograde filling of the basilar via the posterior communicating artery). Marked atherosclerotic irregularity and narrowing of the proximal vertebral artery (arrow).

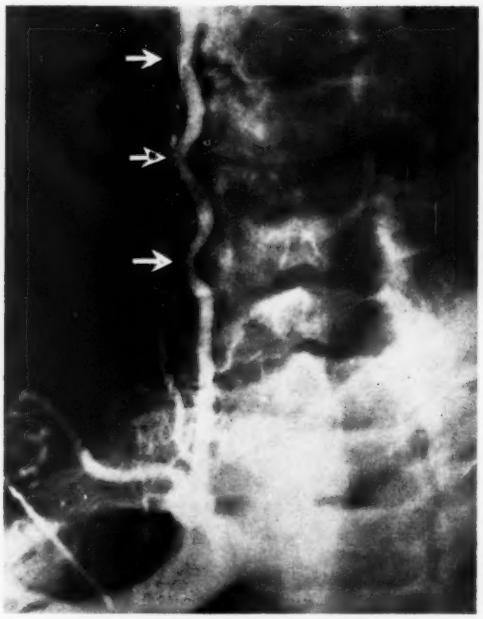

Fig. 6. Narrowing of vertebral artery by pressure of arthritic spurs. Direct retrograde subclavian arteriogram in 55-year-old male with symptoms of dizziness and "blackouts" upon sharp turning of the head. Note definite narrowing of vertebral artery at points of pressure from cervical arthritic spurs (most marked at lower arrow).

the lack of any large vascular communications in this area, with consequent poor collateral potential.

As indicated above, the presence of an intracranial mass may cause either narrowing of vessels or possibly local change in pressure which might result in decreased blood flow through one set of vessels, thereby allowing the development of collateral circulation. This was seen in only 3 cases in our series, all of unilateral subdural hematoma (Fig. 2).

Vascular shunts may also theoretically cause sufficient alteration in normal cerebral blood flow to permit the occurrence of collateral circulation, but in our experience this has rarely been seen. In 2 cases of vascular malformation supplied by the anterior cerebral artery, minor evidence of collateral blood flow was apparent, and 1 case of carotid-cavernous fistula showing an extensive and significant collateral blood flow (Fig. 3) was observed.

Interest in determining the cause of cerebral collateral blood flow where no abnormality could be found in the internal carotid and basilar arteries and their branches has led us to believe that in most, if not all of these patients, there must be some changes more proximally in the vertebral arteries or in the common carotid arteries to explain the altered blood flow. We have therefore recently begun to study such cases by means of complete vertebral arteriography, either by direct injection of the subclavian artery, as described by Crawford, DeBakey, and Fields (9), or by retrograde catheter injection *via* the brachial artery.

As only a few examples of unexplained collateral blood flow have been encountered since this method was instituted, it is impossible to give any significant statistics. We have already seen examples, however, of stenotic vertebral artery (Fig. 4), atherosclerotic disease in the proximal portions of the vertebral artery (Fig. 5), and kinking and narrowing of the vertebral artery because of large cervical arthritic spurs

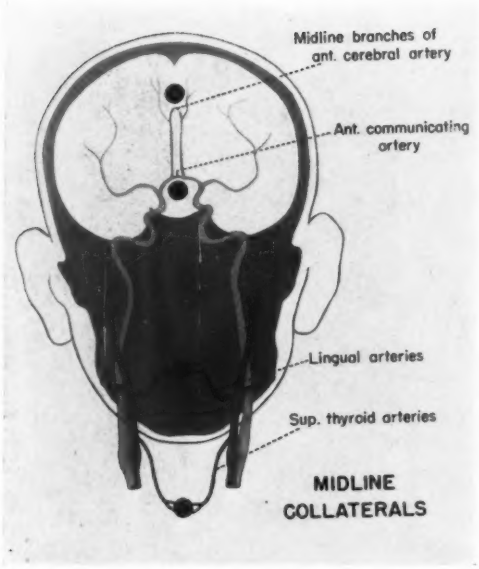


Fig. 7. Potential pathways of collateral circulation across the midline in the head and neck.

(Fig. 6), all factors which might cause collateral circulation more distally. The significance of this last condition has already been indicated by Hutchinson and Yates (10).

## CHANNELS OF COLLATERAL CIRCULATION

The most important collateral channels and, incidentally, those most often demonstrated by angiography, are the relatively large vascular connections in the circle of Willis. Most of these occur between the two internal carotid arteries *via* the anterior communicating artery (Fig. 7). The ease of communication between the internal carotid arteries has been known for many years. In 1901, Crile (11) described temporary occlusion of the internal carotid artery for control of hemorrhage in surgery of the head and neck with the assurance that the opposite carotid would continue to supply both sides of the brain by collateral circulation. Permanent ligation of one internal carotid artery is dependent upon the adequacy of this circulation, examples of which were shown angiographically by Mount and Taveras in 1953 (12). In more recent years many examples of similar collateral circulation incident to occlusion of the internal carotid artery (as shown in Fig. 8) have been published (13–15). This form of collateral circulation has been demonstrated in 20 of 46 cases of complete internal carotid occlusion (Table IV) and in 11 of 29 cases of partial internal carotid occlusion.

TABLE IV: ROUTES OF COLLATERAL CIRCULATION SEEN IN 27 OF 46 CASES OF COMPLETE OCCLUSION OF INTERNAL CAROTID ARTERY

| | Cases |
|---|---|
| 1. From opposite side *via* anterior communicating artery | 20 |
| 2. From external carotid artery *via* ophthalmic artery | 13 |
| 3. From basilar artery *via* posterior communicating artery | 3* |
| 4. From both routes 1 and 2 | 6 |
| 5. From both routes 1 and 3 | 2 |
| 6. From both routes 2 and 3 | 1 |

* Vertebral angiography was performed in only 5 cases of complete internal carotid artery occlusion. This is therefore not a true indication of the importance of this collateral.

Other communications between the vessels of the two sides of the head and neck across the midline may exist but are not commonly demonstrable on angiography. We have, however, seen one example of collateral flow between the two external carotid arteries probably *via* the superior thyroid and lingual arteries (Fig. 9). Communications across the midline *via* the peripheral branches of the anterior cerebral artery are occasionally seen, as in Figure 10.

The other important communication *via* the circle of Willis is between the internal carotids and the vertebral-basilar system (Fig. 11). The importance of this collateral was indicated as early as 1859 by Kussmaul and Tenner (16), who showed that blood flow to the brain was carried on by the vertebral arteries when both internal carotids were compressed. This form of collateral circulation may occur in either direction, depending upon whether the internal carotid artery is narrowed or occluded (Fig. 12) or the basilar artery is affected (Fig. 13). Despite the frequency with which these collaterals were observed in our series (Tables III and IV),

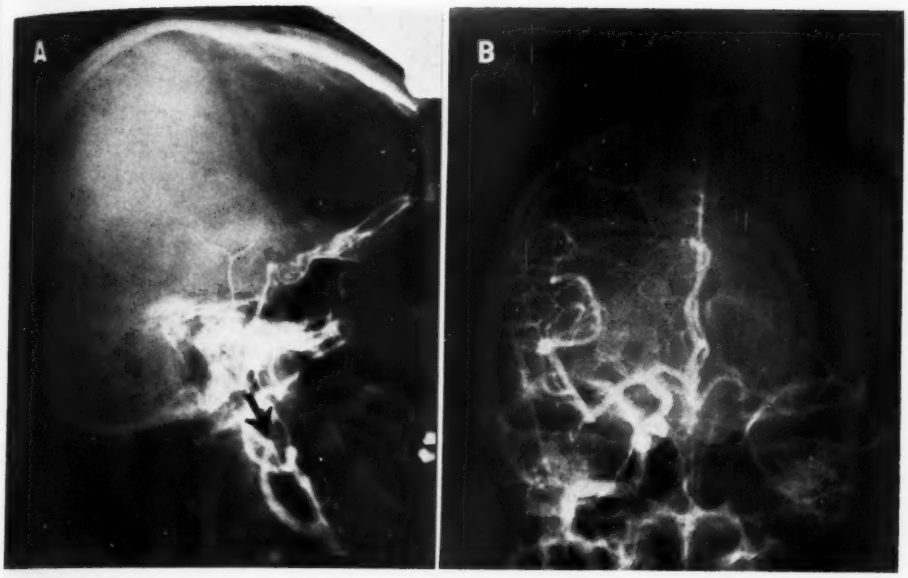


Fig. 8. Occlusion of internal carotid artery in neck with intracranial collateral circulation from opposite carotid *via* anterior communicating artery.

A. Left carotid arteriogram: complete occlusion of internal carotid artery in neck (arrow).

B. Right carotid arteriogram: good collateral filling of left anterior and middle cerebral groups plus retrograde filling of the distal portion of the left internal carotid artery *via* the anterior communicating artery.

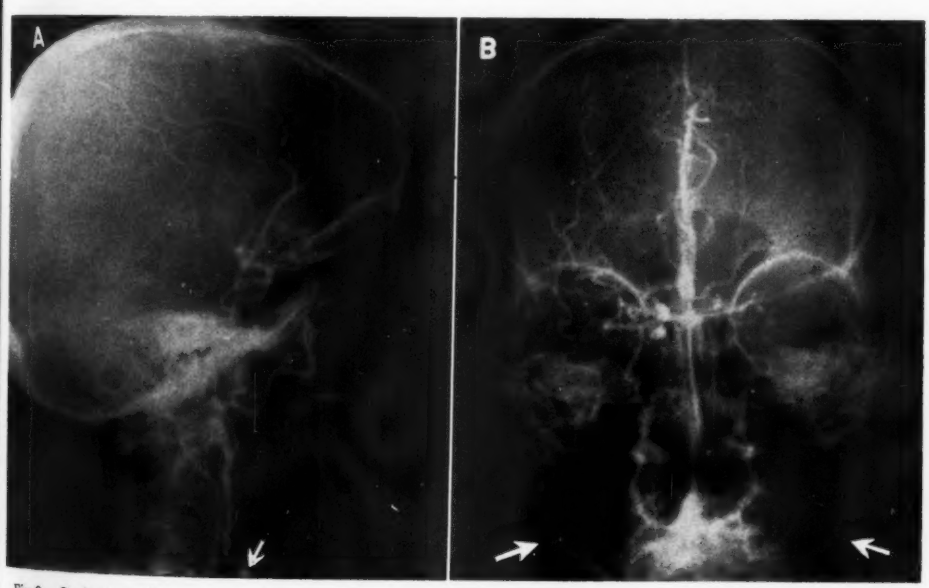


Fig. 9. Occlusion of internal carotid artery in neck with collateral circulation *via* external carotid artery through ophthalmic artery and midline collaterals between the two external carotid arteries.

A. Complete occlusion of right internal carotid artery at its point of origin (arrow) with collateral filling of part of carotid siphon and anterior cerebral group through the ophthalmic artery *via* the external carotid. Note that both external carotids are demonstrable, particularly in the region of the internal maxillary arteries.

B. Better demonstration of both external carotid arteries (arrows) filling *via* right carotid arteriogram, with probably some collateral filling through the left ophthalmic artery, but to a lesser extent than on the right.

Fig. 10. Normal right carotid arteriogram showing filling of distal branches of the left anterior cerebral group *via* midline communications.

references to their demonstration in the literature are uncommon (12, 13, 15, 17, 18).

An unusual form of collateral circulation which exists as a congenital anomaly is the persistence of the carotid-basilar anastomosis (Figs. 11 and 14). This communication is present normally in the fetus as the trigeminal artery, but very rarely does it persist into adult life. Only 23 cases have been reported (15, 19–23), and in but 7 of these has the diagnosis been made during life by angiography. This condition is, however, probably more common than these figures would seem to indicate, since Sunderland found 3 cases in 210 anatomic specimens (19).

The existence of collateral circulation between the extracranial and intracranial vessels is of great importance, yet much less appreciated than the communications discussed above. Perhaps the most important is the network of communications around the orbit, between branches of the external carotid artery and those of the ophthalmic artery (Fig. 15). Numerous reports of the angiographic demonstration of this form of collateral circulation have appeared in recent years (12, 13, 24–30). In our series it could be demonstrated in 13 of 46 cases of complete internal carotid artery occlusion (Table IV). Incidentally, in 6 of these cases there was also evidence of collateral circulation from the opposite carotid by the anterior cerebral, as described previously, and in 1 there was also collateral supply *via* the basilar artery (Fig. 12). Figure 16 shows

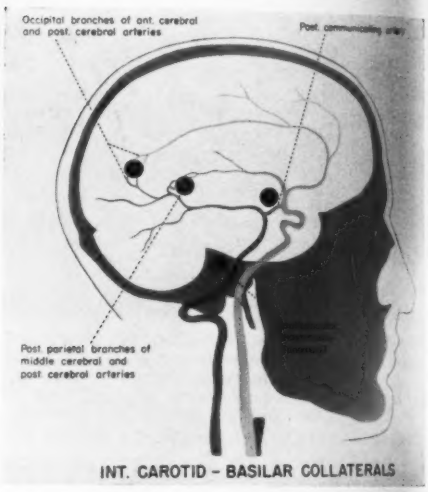
Occipital branches of ant. cerebral and post. cerebral arteries
Post. communicating artery
Post. parietal branches of middle cerebral and post. cerebral arteries
INT. CAROTID – BASILAR COLLATERALS

Fig. 11. Potential pathways of collateral circulation between the internal carotid and basilar arteries.

an example of this ophthalmic pathway, illustrating its importance in maintaining cerebral blood flow in a case of bilateral complete internal carotid occlusion. Six such cases were observed in our series of 33 cases of collateral circulation in complete internal carotid artery occlusion.

Another important potential collateral channel between the extracranial and intracranial vessels is that between the occipital artery, a branch of the external carotid, and the vertebral artery *via* its muscular branches (Fig. 15, No. 6). Figure 4 shows an example of this type of communication which is rarely seen angiographically.

An interesting side light on the above forms of collateral circulation is that they reflect a normal condition in many animals, thus demonstrating the phylogenetic basis for such communications. For example, the main contribution to the circle of

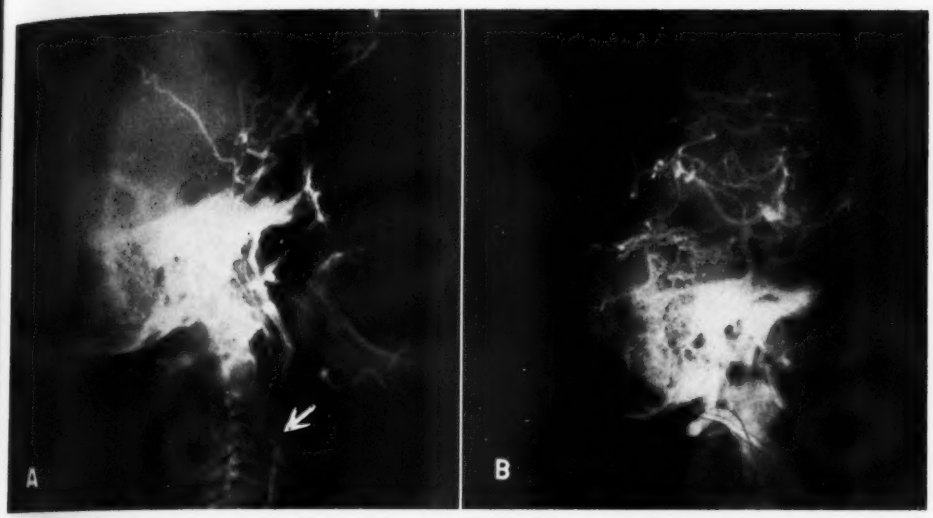


Fig. 12. Occlusion of internal carotid artery with collateral circulation *via* basilar and external carotid arteries.
A. Right internal carotid artery occlusion (arrow) with collateral filling of siphon and part of anterior cerebral group *via* external carotid through ophthalmic artery.
B. Vertebral-basilar arteriogram (retouched), showing much more pronounced collateral filling of all segments of the right anterior and middle cerebral groups *via* the posterior communicating artery. (Filling of external carotid branches in neck may be occurring through the occipital artery or, more likely, by retrograde flow through the innominate artery since this is a right vertebral injection).

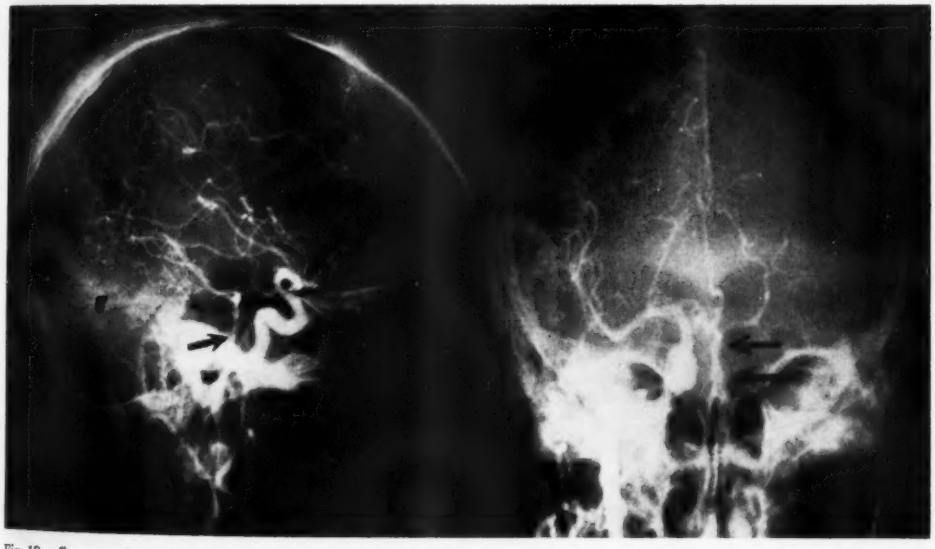

Fig. 13. Severe atherosclerotic narrowing of basilar artery (arrows) with good collateral filling from the internal carotid artery *via* the posterior communicating (right carotid arteriogram).

Willis in the dog and cat, and in some other feline species, is from the external carotid artery, rather than the internal carotid, and blood enters the skull by means of a network of vessels (*rete mirabili*) in the orbit, which thus corresponds to the ophthalmic collateral system seen in man. In the horse and ox, on the other hand, the occipital branch of the external carotid artery is the major vessel supplying the cir-

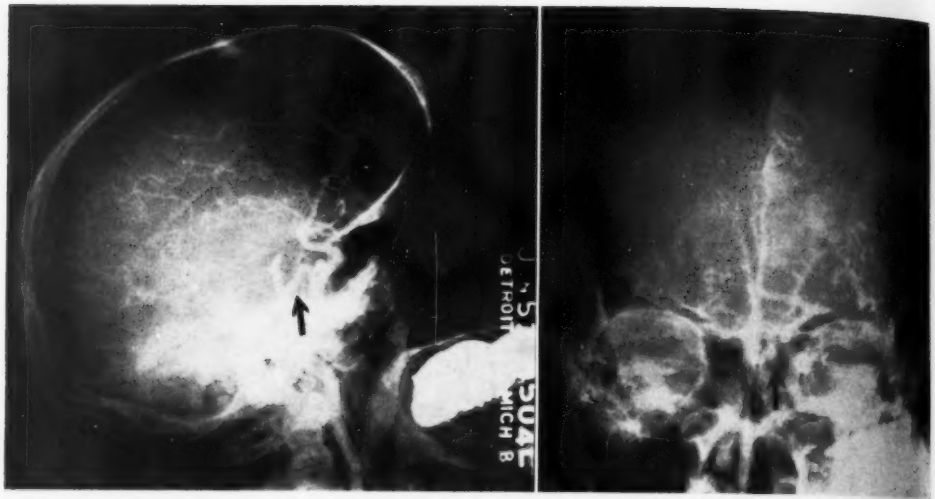

Fig. 14. Carotid-basilar anastomosis (persistent trigeminal artery) demonstrated by carotid arteriogram (see diagram, Figure 11). Anastomosis (arrows) is lower in position and much larger than posterior communicating artery. No posterior communicating artery visualized, suggesting congenital absence. Basilar artery fills well with somewhat faint filling of its branches during left carotid arteriogram.

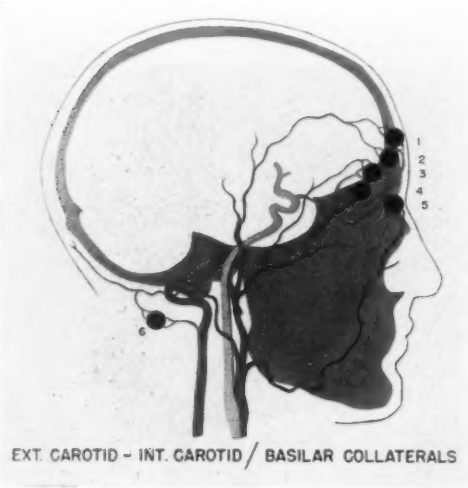


Fig. 15. Potential pathways of collateral circulation from external carotid to internal carotid artery and from external carotid to vertebral-basilar artery.

1. Frontal (anterior terminal) branch of superficial temporal artery to frontal branch of ophthalmic artery.
2. Frontal branch of superficial temporal artery to supraorbital branch of ophthalmic artery.
3. Orbital (lacrimal) branch of middle meningeal artery to lacrimal branch of opththalmic artery.
4. Terminal branches of anterior deep temporal artery to lacrimal branch of ophthalmic artery.
5. Angular and lateral nasal branches of external maxillary artery to dorsal nasal branch of ophthalmic artery.
6. Occipital artery to muscular branches of vertebral artery.

cle of Willis through the vertebral-basilar system, corresponding to the human occipital-vertebral collateral pathway (31, 32).

Another important but infrequently recognized group of collateral communications consists of those occurring over the surface of the cerebral hemispheres between the peripheral branches of the anterior and middle cerebral groups (Fig. 17), and those between the distal branches of the posterior cerebral artery and branches of the anterior and middle cerebral groups (Fig. 11). The existence of these collaterals was indicated by Fay as early as 1925 (4), but their significance has never been fully appreciated, although there have been several examples of their angiographic demonstration (12–15, 33–36). Vander Eecken and Adams published an excellent discussion of the anastomotic channels between these surface vessels in 1953 (37).

In our series of 37 cases of complete anterior cerebral artery occlusion, evidence of collateral filling of the distal branches by way of the middle cerebral artery branches was found in 5 (Fig. 18). In 19 cases of occlusion of the middle cerebral artery there were 2 examples of

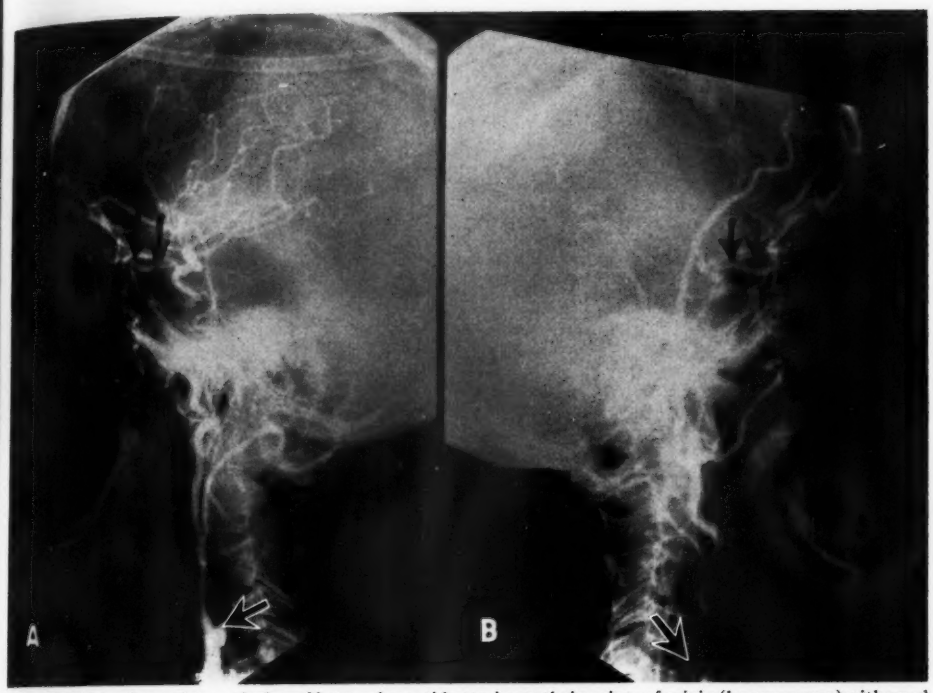


Fig. 16. Bilateral complete occlusion of internal carotid arteries at their points of origin (lower arrows) with good collateral circulation filling the anterior and middle cerebral groups on each side from the external carotid arteries via the markedly dilated ophthalmic arteries (upper arrows). A. Left carotid arteriogram. B. Right carotid arteriogram.

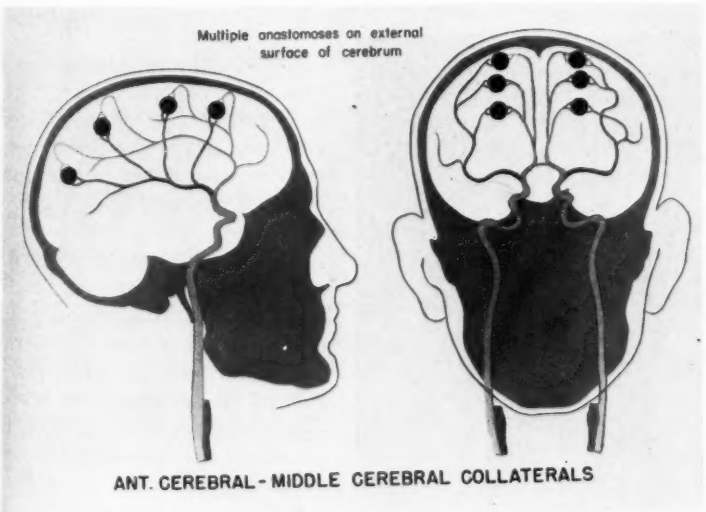


Fig. 17. Potential pathways of collateral circulation *via* distal branches of the anterior and middle cerebral arteries.

collateral filling *via* the peripheral branches of the anterior cerebral artery (Fig. 19). Only 1 case of collateral circulation to the anterior cerebral artery *via* the posterior cerebral was seen (Fig. 20), but vertebral angiography was performed in only 6

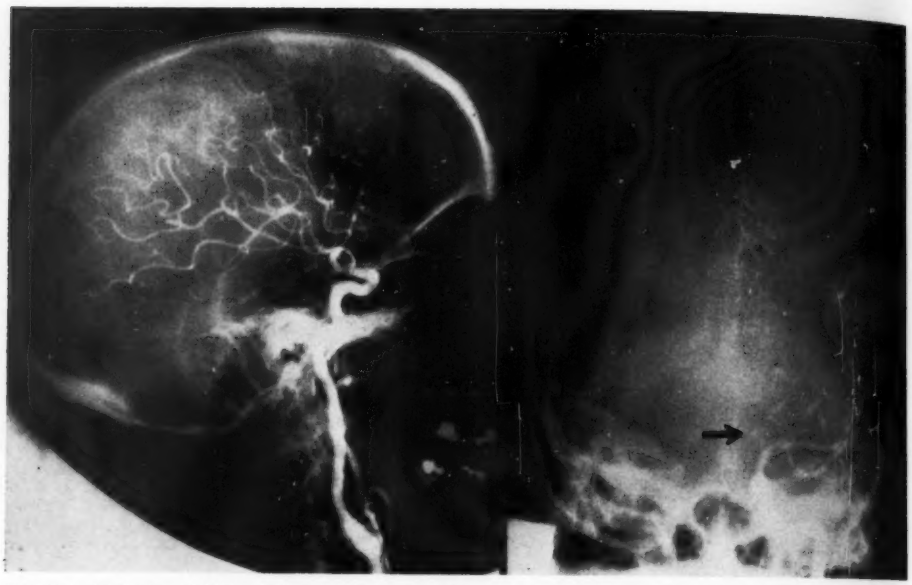

Fig. 18. Occlusion of left anterior cerebral artery (arrow) with good filling of its peripheral branches *via* the middle cerebral artery branches, seen best on the anteroposterior view.

of 37 cases of anterior cerebral artery occlusion. In no case was a collateral demonstrated from the posterior cerebral to the middle cerebral branches, although in none of our cases of middle cerebral artery occlusion was vertebral angiography done, and this finding is therefore not statistically valid.

Fig. 19. Complete occlusion of right middle cerebral artery near its origin (arrow) with filling of its peripheral branches *via* the distal branches of the anterior cerebral artery.

## SUMMARY

Collateral circulation to the brain is a well documented fact. It is particularly well shown by means of cerebral angiographic studies. Such communications explain why many patients with occlusive cerebral vascular disease survive and sometimes even show complete recovery.

The known anatomical communications between the various cerebral vessels have been shown diagrammatically, and the existence of actual collateral circulation through these channels has been demonstrated by means of cerebral angiography. The various causes of such collateral circulation are enumerated, with specific statistical evidence given for its common occurrence, particularly in cerebral occlusive vascular disease.

Rarely, if ever, does collateral circulation occur in the normal person, and evidence of such communication should lead to a search for its cause. If the cause is not

Fig. 20. Occlusion of anterior cerebral artery with collateral circulation *via* posterior cerebral branches.
A. Right carotid arteriogram: occlusion of anterior cerebral artery just distal to posterior communicating (arrow).
B. Vertebral-basilar arteriogram: filling of pericallosal branches of right anterior cerebral artery *via* the occipital branches of the posterior cerebral artery.

found in the internal carotid or basilar arteries, then complete evaluation of the vertebral and common carotid arteries, particularly at their points of origin, must be made.

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SUMMARIO IN INTERLINGUA

## Vias de Cerebro-Circulation Collateral

Le existentia de circulation collateral verso le cerebro es un facto ben documentate que se revela con claritate particular in studios cerebro-angiographic. Tal communicationes explica le constatation que multe patientes supervive a occlusive morbo vascular e a vices se restabli mesmo completemente.

Le cognoscite communicationes anatomic inter le varie vasos cerebral es illustrate diagrammaticamente, e le existentia de ver circulation collateral per iste canales es signalate. Le varie causas de circulation collateral es enumerate, e specific datos statistic es citate que demonstra in particular su occurrentia commun in morbo occlusive cerebrovascular. Il es rar, e possibilemente non occurre del toto, que tal communicationes es presente in subjectos normal. Su apparition debe inspirar le investigation de su causa.

Le plus importante canales collateral es le relativemente grande connexiones vascular in le circulo de Willis, como inter le duo arterias carotic interne via le arteria communicatori anterior. Altere communicationes occurre inter le interne arterias carotic e le systema vertebro-basilar, inter le vasos extra- e intracranial, inter le brancas peripheric del gruppos antero-cerebral e meso-cerebral. Un anastomose que es normalmente presente in le feto in le forma del arteria trigeminal persiste a vices usque al etate adulte.

Le presente articulo include un evalutation de 364 normal arteriogrammas carotic e le studio de 191 casos de complete o partial occlusion del vasos cerebral.

# Roentgen Manifestations of Multiple Cysts of the Renal Medulla[1]

HAROLD F. IBACH, M.D., and LAWRENCE L. LARSEN, M.D.

IT IS OUR PURPOSE to review certain pertinent radiological aspects of the clinicopathological entity, multiple cysts of the renal medulla. This was initially described in 1949 by Cacchi and Ricci (1) as "sponge kidney," and subsequently in 1951 by Vermooten (2) as "congenital idiopathic dilatation of the collecting tubules." The only previous reference to this condition in the American radiological literature was by Abeshouse and Salik (3).

Although the condition is uncommon, it is easily recognized if one is aware of its existence. We believe the urographic manifestations to be characteristic and the radiologist's impression may provide important diagnostic information. In the 2 cases to be presented here the diagnoses were made by excretory urography.

## CASE PRESENTATIONS

CASE I: E. F., a 33-year-old colored female, was admitted to St. Michael Hospital on Feb. 28, 1959, with a history of hematuria for four days prior to admission. She also complained of discomfort on the left side of the abdomen. She had had single episodes of hematuria in 1954, when she was seven months pregnant, and again in 1957 and 1958. The past history and physical examination were otherwise noncontributory.

Fig. 1. Case I. Excretory urogram showing small multiple bilateral cysts surrounding the minor calyces.
Fig. 2. Case I. Enlarged view of right kidney.

Excretory urograms taken at the University of Minnesota Hospitals, dated Feb. 11, 1958, demonstrated bilateral grape-like cysts located in the medullary portions of both kidneys, communicating with the minor calyces (Figs. 1 and 2).

[1] From the Department of Radiology, St. Michael Hospital, Milwaukee, Wis. Accepted for publication in December 1959.

Repeat excretory urography, on March 5, 1959, again revealed multiple cysts in the renal medulla, bilaterally, showing no significant change from the previous examination (Fig. 3). No calculi were present. A roentgenogram of the chest was normal.

Hematology and blood chemistry reports were normal. Urinalysis showed gross hematuria. Urine collected from the right and left kidneys contained gram-negative bacilli. Direct smear and culture of the urine for acid-fast bacilli were negative.

Cystoscopy showed the interior of the bladder to be normal. Grossly bloody urine was draining from the right ureteral orifice.

Fig. 3. Case I. Excretory urogram after a thirteen-month interval, showing similar urographic manifestations.

CASE II: J. S., a 23-year-old white female, was admitted to St. Joseph Hospital on Aug. 10, 1959, complaining of pain in her right side, beginning four days prior to admission. The pain was localized at the right costovertebral angle. Other symptoms were fever, frequency, and dysuria. On July 19, 1959, the patient had experienced a similar pain on the right side, with frequency and dysuria, which lasted for four days. The physical examination was noncontributory.

Excretory urograms revealed multiple cystic cavities of various sizes located in the renal medulla, surrounding all of the minor calyces on the right (Fig. 4). A right retrograde pyelogram confirmed the presence of these multiple cysts in the medulla. The right renal pelvis and right ureter were normal (Fig. 5).

The hematologic and blood chemistry determinations were normal. Urinalysis revealed occasional erythrocytes and numerous leukocytes. Fractional urine specimens were obtained from the bladder and both kidneys. The bladder specimen contained 75 leukocytes and an occasional erythrocyte per high-power field. Gram stains and cultures were negative for acid-fast and other organisms.

Cystoscopy showed several small areas of submucosal hemorrhage. Clear urine flowed from the left ureteral orifice. Milky urine drained from the right ureteral orifice.

A right nephrectomy was performed on Aug. 17, 1959. The upper pole of the right kidney was adherent to the renal bed due to a perinephritic reaction. Gram-negative bacilli, identified as *E. coli*, were cultured from the surgical specimen. At the corticomedullary junction and within the medullary columns were small cysts of various sizes, lined by low cuboidal or columnar epithelium. Some of the cysts contained yellow-green purulent material resembling abscesses (Fig. 6). Microscopically these cysts were lined by nonspecific pyogenic granulation tissue (Figs. 7 and 8).

## ROENTGEN FEATURES

The appearance of cysts of the renal medulla as demonstrated by either excretory urography or pyelography is diagnostic. The condition may be primarily unilateral or bilateral, as illustrated by these two case presentations. The outstanding feature is the presence of multiple cyst-like cavities in the renal pyramids, adjacent to or surrounding the terminal portions of the minor calyces. The cav-

Fig. 4. Case II. Excretory urogram demonstrating multiple small medullary cysts in the right kidney.
Fig. 5. Enlarged view of right kidney.

ities vary in size and shape, resulting in distortion or compression of the calyces. In a series of 35 cases described by Lindvall (4), the changes varied from a few cavities in a single pyramid to multiple cavities in all of the pyramids bilaterally. Most authors feel that the kidneys are either of normal size or slightly larger. Both Lindvall and Lhez (5) found that in the majority of their cases there was an associated enlargement of the pyramids and minor calyces. Lindvall reported enlargement of the entire kidney in 13 of his 35 cases. Unless complications are present, the kidneys ordinarily function well.

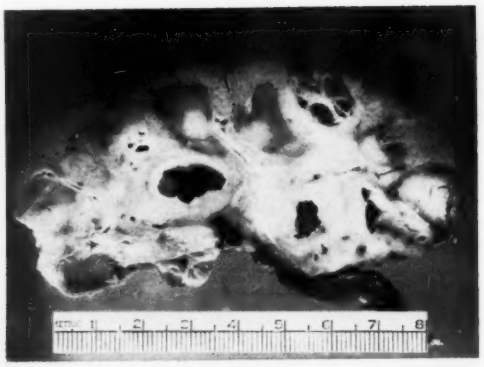

Fig. 6. Case II. Large irregular chronic abscesses scattered throughout the kidney. Note areas of chronic pyelonephritis and cortical surface scarring.

Fig. 7. Case II. Medullary cysts lying within dense cellular fibrous tissue. Entrapped tubular structures are also present.

The most common complication is the occurrence of calculi throughout the medullary portion of the kidney. In our first case, no calculi were demonstrable on the conventional scout film of the abdomen. In the second case, calculi could not be visualized on the radiographs or in the

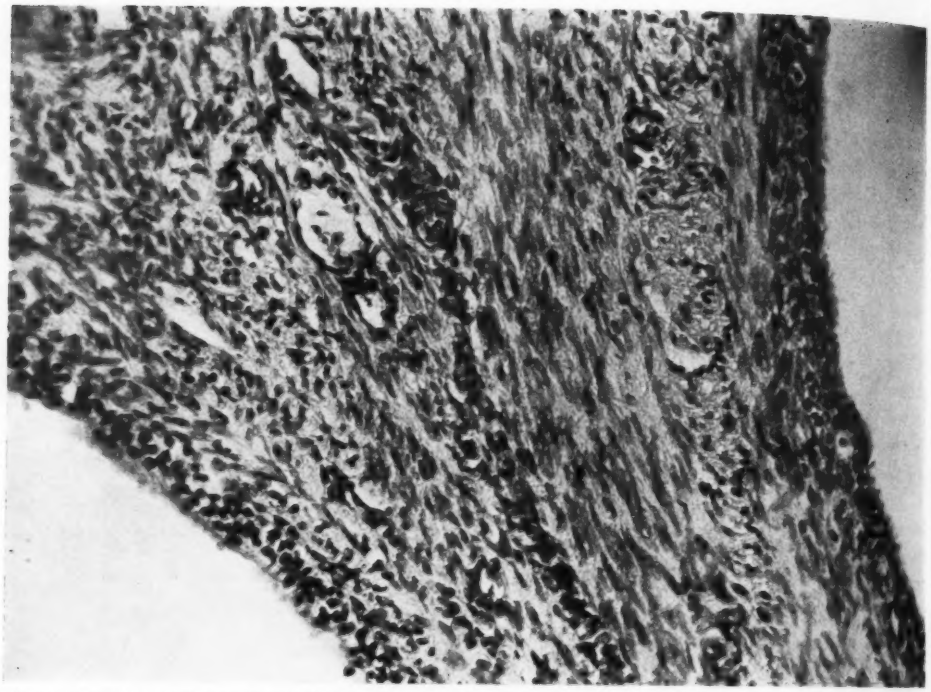

Fig. 8. Case II. Portions of medullary cysts lined by tall columnar epithelium and surrounded by richly cellular fibrovascular tissue.

surgical specimen. Lhez reported the presence of calculi in 2 of his 12 cases. Lindvall, however, found calculi in 33 of 35 cases. Rubin, Ross and Turner (6) presented one case exhibiting no radiologic change in the appearance of the medullary cysts over a ten-year period, except for the development of small stones in the cysts.

## DISCUSSION

Renal tuberculosis is the most important consideration in the differential diagnosis. There was no clinical or radiological evidence of systemic or renal tuberculosis in either of our cases, and a review of the literature yielded only a single case where tuberculosis existed as a concomitant infection. One would anticipate that tuberculous lesions of this magnitude would show evidence of calcification and impairment of renal function.

The characteristic pyelographic appearance and clinical manifestations differentiate congenital polycystic disease of the kidneys and pyeloureteritis cystica from cysts of the renal medulla.

Renal papillary necrosis occurs most commonly in diabetic patients or in nondiabetic patients with associated urinary tract obstruction. The ring-shaped shadows demonstrable on the radiographs, representing the necrotic papillae, do not resemble medullary cystic disease.

Case II illustrates a complicating pyelonephritis with a fulminating course leading to nephrectomy within four weeks after the onset of symptomatology. In a previous publication (7) a similar case was described in a thirty-eight-year-old man with a nine-year history of recurrent pyelonephritis, with nephrectomy when the infection did not respond to medical treatment. The urographic changes of pyelonephritis include varying degrees of pyelocaliectasis with bizarre deformity of the calyces.

Smith and Graham (8) reported a case of medullary cysts of the kidneys in an

eight-year-old female, complicated by intractable anemia, which terminated in death. There were no antecedent history, symptoms, or signs of renal disease.

We feel that the roentgen finding of tubular stasis as manifested by radiating striations from the minor calyces does not represent a similar or related entity. This phenomenon occurs more commonly with the use of abdominal compression during excretory urography.

It has become increasingly apparent that the occurrence of multiple cysts in the renal medulla is not as rare as was originally believed. Probably the most acceptable etiological explanation is that proposed by McKenna and Kampmeier (9). After examining numerous sections of fetal kidneys, they demonstrated that the first three or four generations of convoluted tubules become vestigial. They suggested that medullary cysts may be the result of abnormal persistence of these vestigial structures. Until more cases have been reported, with histopathological data, it is doubtful that a single fundamental concept will be accepted.

Conservative medical treatment in the uncomplicated case is indicated. When complications occur, with involvement of a single kidney, surgical resection may effect a cure.

## CONCLUSION

Two cases of medullary cysts of the kidneys have been presented. The radiographic manifestations are characteristic and diagnostic. Due to a complication in the second case, the clinical features are quite dissimilar. Since it is apparent that this condition is not rare, its recognition will facilitate the correct therapeutic approach.

ACKNOWLEDGMENTS: The authors extend their sincere thanks to the following persons whose efforts contributed to this paper: Charles H. Altshuler, M.D.; James W. Sargent, M.D.; Gene W. Sengpiel, M.D.; Joseph L. Teresi, M.D.; Joseph F. Wepfer, M.D.

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## SUMMARIO IN INTERLINGUA

### Roentgenomanifestationes de Cystes Multiple del Medulla Renal

Es reportate duo casos de cystes multiple del medulla renal, un condition que esseva describite originalmente como "ren spongiose." Le apparentia del urogramma o pyelogramma excretori es diagnostic. Le duo hic presentate casos esseva diagnosticate per urographia excretori. Le aspecto le plus prominente es le presentia de multiple cavitates cystoide in le pyramides renal, uni- o bilateral, in adjacentia o incirculation del portiones terminal del calyces minor. Le cavitates varia in dimension e conformation, con le resultato de un distortion o compression del calyces. In le absentia de complicationes, le renes usualmente functiona ben.

In un del casos hic reportate, un pyelonephritis complicatori esseva presente, con un curso fulminante que demandava nephrectomia. In non-complicate casos, mesuras conservatori es indicate.

# Small-Bowel Tumors[1]

WILLIAM MARTEL, M.D., WALTER M. WHITEHOUSE, M.D., and FRED JENNER HODGES, M.D.

SMALL-INTESTINAL lesions, excluding peptic and postoperative jejunal ulcers, are not common; neoplasms supposedly are rare. When repeated examinations of the gallbladder, the esophagus, stomach and duodenum, and the colon fail to provide an explanation for persistent gastrointestinal symptoms, however, the possibility of small-bowel disease deserves careful consideration and investigation. Inflammatory processes involving the small bowel commonly produce early and severe symptoms and well defined clinical signs, while neoplasms, unless they obstruct, frequently cause only vague and insidious abdominal disturbances. This relative quiescence, coupled with infrequent occurrence, commonly results in delay in diagnosis. Furthermore, nonobstructive tumors may escape recognition even when specific radiologic search is made, because the resultant deformity may be slight and is characteristically limited to a short segment of gut. The frequency with which symptomatic tumors remain undiagnosed prior to operation or postmortem examination warrants a discussion of the difficulties encountered in their radiologic detection, identification, and differential diagnosis.

## MATERIALS AND METHOD

Publications dealing with small-bowel tumors are largely based upon surgical and necropsy case material (1, 2, 3). The cases here reported are limited to small-bowel tumors treated surgically upon the basis of preoperative symptoms which warranted or should have called for a radiological small-bowel survey in the face of normal stomach and colon x-ray findings. Tumors discovered fortuitously at operation have not been included.

Metastatic tumors were omitted, as were duodenal carcinomas for which an ampullary, biliary, or pancreatic origin could not be excluded. Identification of the primary nature of all small-bowel carcinomas was accepted with circumspection because, not uncommonly, a tumor which at the time of operation appears to be primary may be shown at necropsy to have been a metastasis. Diagnosis of the three carcinomas in this group of small-bowel tumors is based upon clinical and surgical findings and upon the histologic examination of tissue which was removed at operation.

In 17 patients with primary small-bowel tumor encountered during the six-year period, 1952–1958, radiologic findings have been reviewed and correlated with observations at operation and with pathologic reports. No attempt has been made to investigate the frequency or the underlying causes of false positive radiologic diagnoses of small-intestinal tumors.

## RESULTS

Correlation of the roentgen manifestations and pathologic data is given in Table I. After review of the original radiologic interpretations, errors were analyzed as shown in Table II. A diagnosis of neoplasm was made in 6 instances. In all of these the tumor was situated either in the duodenum or in the proximal jejunum. A nonspecific abnormality was recognized in 2 patients; this consisted of mechanical small-bowel obstruction in 1 patient (Case 2) and an abnormal small-bowel pattern in another (Case 7). The small-bowel examination was therefore informative in 8 of the 17 patients. An abnormality, manifest on the films but overlooked at the time of reporting, was classed as an error. In 2 patients (Cases 4 and 6) this consisted of a single dilated bowel loop proximal to the lesion. In 5 instances the small bowel was incompletely examined.

[1] From the Department of Radiology, The University of Michigan, Ann Arbor, Mich. Accepted for publication in December 1959.

TABLE I: PATHOLOGIC AND X-RAY FINDINGS IN 17 CASES OF SMALL-BOWEL TUMOR

| Case No. | Tumor Type | Location | Gross Pathologic Characteristics | X-Ray Findings in Retrospect |
|---|---|---|---|---|
| 1 | Carcinoma | Proximal jejunum | Extensively infiltrating polypoid mass with cavity | Mucosal destruction |
| 2 | Carcinoma | Distal ileum | Annular with obstruction | Mechanical small bowel obstruction |
| 3 | Carcinoma | Proximal jejunum | Annular with constriction | Mucosal destruction |
| 4 | Carcinoid | Mid-ileum | Multiple submucosal nodules with constriction | Proximal dilated loop, insufficient films |
| 5* | Carcinoid | Distal ileum | Nodular, intramural | Insufficient films |
| 6* | Carcinoid | Mid-ileum | Annular with constriction | Proximal, dilated loop; insufficient films |
| 7 | Reticulum-cell sarcoma | Proximal jejunum | Ulcerating mucosal nodule. Diffuse mesenteric adenopathy | Nodule not visualized; "abnormal pattern" |
| 8 | Reticulum-cell sarcoma | Proximal jejunum | Six infiltrating masses, up to 2 cm. in diameter | Insufficient films |
| 9* | Lymphosarcoma | Mid-ileum | Mass, 13 × 11 × 9 cm., encircling bowel | Insufficient films |
| 10 | Leiomyosarcoma | Proximal jejunum | Ulcerating mass, 20 cm. diameter, replacing bowel wall | Ulcerating mass |
| 11 | Leiomyosarcoma | Duodenum II | 11 × 5 × 5-cm. mass with cavity, replacing bowel wall | Ulcerating mass |
| 12 | Leiomyoma | Proximal jejunum | Circumscribed intramural mass, 3 × 2 × 1.5 cm. | Not visualized |
| 13 | Leiomyoma | Proximal jejunum | Circumscribed, intramural mass, 5 × 4 × 4 cm. | Filling defect |
| 14 | Hemangioma | Multiple; large and small bowel | Circumscribed, submucosal nodules, 1 to 2 cm. in diameter | Not visualized in small bowel; 2 colonic filling defects |
| 15† | Undifferentiated sarcoma | Duodenum II | Lobulated mass, 10 cm. in diameter, with short stalk | Filling defect |
| 16† | Well differentiated sarcoma (possibly neurosarcoma) | Duodenum III | Circumscribed submucosal mass, 3 cm. in diameter; central ulcer | Filling defect with central ulcer |
| 17† | Well differentiated leiomyosarcoma | Duodenum III | Circumscribed submucosal mass, 4 × 2 cm. | Filling defect with central ulcer |

* Biliary stone was an incidental finding at surgery, diagnosed, in all cases, prior to operation. This was unrelated to patient's symptomatology.
† Previously reported (27).

TABLE II: ACCURACY OF ROENTGEN DIAGNOSIS*

| | Case Nos. | Totals |
|---|---|---|
| Correctly identified as neoplasm | 10, 11, 13, 15, 16, 17 | 6 |
| Nonspecific abnormality | 2, 7 | 2 |
| Signs of neoplasm overlooked | 1, 3, 4, 6 | 4 |
| Inadequate filming (area of lesion not seen) | 4, 5, 6, 8, 9 | 5 |
| Filming adequate; lesion not shown | 7, 12, 14 | 3 |

* Cases 4, 6, and 7 are classified in 2 categories.

One or two abdominal films after stomach examination were obtained in Cases 4, 5, and 6, and in these much of the small bowel, usually the distal part, was not included; in Cases 8 and 9 the stomach and duodenum were examined but specific small-bowel investigation was not requested. There were 3 benign tumors in the series; in 2 of these patients (Cases 12 and 14) the examination was adequate, but no evidence of tumor was observed either at the time or in retrospect. In addition to the diffuse mesenteric adenopathy which was responsible for the sprue-like pattern in Case 7, there was an ulcerating mucosal lesion which was not shown. Except in Cases 4 and 11, the interval between x-ray examination and surgical treatment was less than one month.

The long duration of symptoms prior to laparotomy was noteworthy. This period exceeded ten months in 11 instances and was eight months or more in 6 others. In most patients the symptoms were caused by chronic anemia due to blood loss and,

in some, by intermittent or incomplete intestinal obstruction. Guaiac-positive reports on two or more stools were accepted as minimal evidence of intestinal bleeding. On this basis, 13 of the 17 patients showed intestinal blood loss; 8 of these had gross melena or hematemesis at some time during the symptomatic period.

## DISCUSSION

Small-bowel neoplasms are uncommon but hardly to be considered rare. Weibel *et al.* (4) collected 100 malignant and 65 benign tumors from four hospitals over sixteen years. Elias *et al.* (5) found 32 malignant and 57 benign tumors over a twenty-year period. Bernstein and Chey (3) discovered 109 small-bowel tumors of various types in a review of both surgical and necropsy files for a twenty-five-year period; 74 of these were symptomatic, giving a case rate of 3 per year. The rate in our series is comparable. Although small-bowel tumors are uncommon, they deserve critical discussion since they may be suspected in patients with persistent, unexplained intestinal symptoms.

*1. Technic:* The length of the small bowel, its relative mobility and redundancy, and the ease with which its liquid contents may bypass a partially obstructing lesion, all contribute to the difficulty of its examination. The opacification by barium, being a passive process dependent upon peristalsis, cannot be as well controlled in the small intestine as in the stomach or colon. It is understandable why a small lesion, which does not cause partial obstruction, may readily escape detection. There is much, however, that a radiologist can do to improve the accuracy of his investigation if he is apprised beforehand that a small-bowel lesion is suspected.

The practice of obtaining one or two "small-bowel films" after examining the stomach and duodenum is at best a screening procedure and failure to disclose a small-bowel lesion by this means may preclude more elaborate search and lead to unwarranted reassurance. While it is admittedly impossible to visualize every foot of small intestine by multiple exposures, all of the major portions of the small bowel must be radiographed if exploration is to be considered adequate. Filming at widely spaced, fixed intervals without regard to the rate of transit of the barium is to be discouraged. The timing should be such as to demonstrate continuous progression of barium when the roentgenograms are viewed in sequence. Fluoroscopy and spot-filming of suspicious areas and the terminal ileum should be employed when indicated.

The use of 16 ounces of barium in routine small-bowel examinations offers several advantages. The resultant distention of the stomach causes a more constant flow through the pylorus and hence a more continuous barium column in the bowel. Secondly, a reduction in small-bowel transit time can be expected, minimizing the tendency for the barium to precipitate in the distal ileum and permitting clearer delineation of the intestinal wall. Localized dilatation proximal to a partially obstructing lesion is an important and often overlooked clue to the presence of an organic abnormality; this is especially true in the ileum, where normal variations in caliber are not as great as in the jejunum. The demonstration of multiple contiguous loops of small bowel on a single film facilitates detection of minimal dilatation by comparison with adjacent loops of normal caliber. Although it is granted that with this technic a small lesion may be obscured by superimposed segments, it is felt that such lesions are not demonstrated more frequently with smaller amounts of barium. Furthermore, this disadvantage may be overcome to some extent by the use of serial exposures at sufficiently short intervals to allow revisualization of the same diseased loop. Large quantities of barium are indispensable in those instances where a sizable extra-alimentary cavity communicates with the intestine or where there is marked generalized dilatation. It is our feeling that partial or complete small-bowel obstruction is not a contraindication to the judicious use of

barium suspension, because the fluid content of this portion of the gut makes inspissation unlikely.

Tumors of the duodenojejunal junction merit special attention for, though easily accessible in routine barium-meal examinations, they may readily be obscured by the overlying stomach. It is of interest that 7 of the tumors (Cases 1, 3, 7, 8, 13, 16, 17) were located beyond the descending duodenum and within a short distance of the ligament of Treitz. In none of the first 4 was the diagnosis made prior to laparotomy and in 2 of these, positive roentgen findings were overlooked. A tumor was diagnosed in 3 instances, but in each case, only after repeated examination. Bernstein and Chey (3) noted that 7 out of 9 jejunal carcinomas were located within 1 foot of the ligament of Treitz, and in only 2 of these cases was the correct x-ray diagnosis made. In conventional postero-anterior views, barium in the stomach usually obscures the retrogastric portion of duodenum and jejunum, but with the patient supine these segments are more easily visualized. Routine fluoroscopy of this area is mandatory. In some cases the supine right posterior oblique view is advantageous. We have often observed the involvement of the duodenojejunal region or the terminal ileum by metastatic tumor. It is reasonable that these segments, being fixed in the retroperitoneal space at the base of the small-bowel mesentery, are more likely to reflect the presence of contiguous retroperitoneal masses on radiological examination. Such metastases may cause nodularity of the bowel wall, mucosal ulceration or distortion, extrinsic pressure deformity, or intestinal obstruction.

*2. Roentgen Appearance:* The difficulty of correctly diagnosing benign tumors preoperatively and the importance of careful x-ray examination are pointed out by River *et al.* (6), who in a comprehensive review cite a number of instances in which multiple operations were required before the tumor could be found. At times it was discovered only at necropsy after unsuccessful surgical search.

Fig. 1. Case 12. Smooth filling defect due to jejunal leiomyoma. Several additional films, adequately showing this area, did not demonstrate the tumor.

Noninvasive submucosal tumors characteristically produce a smooth arcuate defect with distinct borders (Figs. 1 and 2, A), which forms wide angles with the adjacent bowel wall (Fig. 2, B). The overlying mucosa is stretched, with resultant effacement of its markings. In the case of leiomyomas a sharply outlined central ulcer crater may be seen. If only an *en face* view is obtained, differentiation cannot be made from an intraluminal mucosal tumor where the pedicle is not shown. If the tumor is large, an extramural mass may be seen. Small, circumscribed lesions which appear grossly benign may show histologic evidence of malignancy and it is, therefore, hazardous to predict benignity on the basis of the radiologic picture (Fig. 2).

Primary carcinomas usually involve short segments and cause irregular luminal narrowing with proximal dilatation and mucosal ulceration. An overhanging edge is characteristic and is due to the presence of the rigid, infiltrating tumor with abrupt transition to the relatively uninvolved wall; the normal elasticity of the latter allows

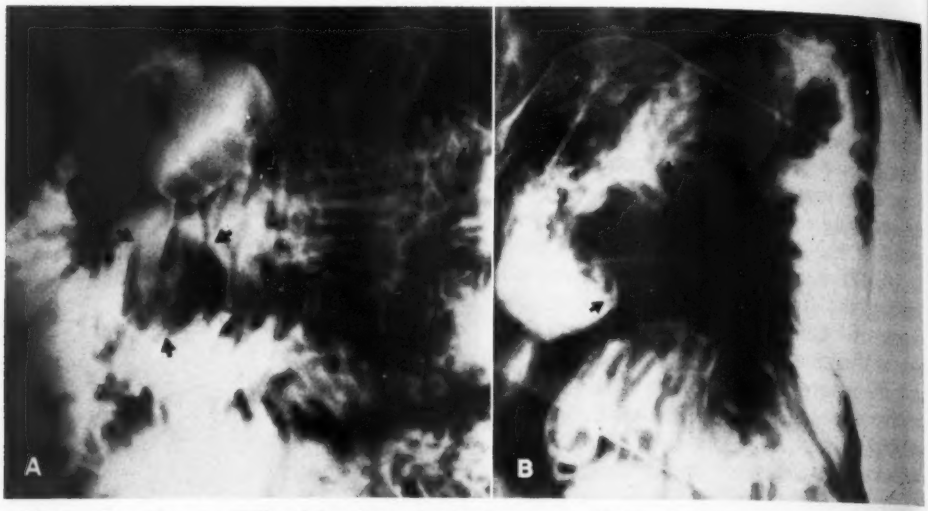


Fig. 2. Case 16. A. Filling defect due to duodenal sarcoma. Note central ulcer crater. B. Oblique view with compression showing arcuate filling defect which forms wide angles with the adjacent bowel wall. The ulcer crater is visible (central arrow). Appearance is pathognomonic of an intramural mass. Note compression block.

distention by the pressure of intraluminal fluid. When the tumor is diffuse or of scirrhous type or when the elasticity of the adjacent bowel is compromised, overhanging edges will not be observed; this is true in instances where the tumor has perforated and caused a large, limiting extramural inflammatory or neoplastic mass (Fig. 3). If the quantity of barium delivered to the point proximal to the lesion at the time of exposure is insufficient to cause distention of this segment, then it will be impossible to recognize overhanging edges (Fig. 4). This is particularly true in incompletely obstructing carcinomas of the small bowel, where the degree of filling depends on peristalsis and is beyond our control.

Sarcomas are cellular tumors which do not produce a desmoplastic reaction and are, therefore, not apt to cause luminal constriction; this feature of dilatation rather than constriction was first described in relation to lymphosarcomas by Zimmer (8), in 1923. When there is extensive replacement of muscle by tumor, the involved segment becomes dilated (Fig. 5). One should consider the diagnoses of malignant lymphoma, leiomyosarcoma, and retroperitoneal sarcoma invading bowel, in the presence of large masses associated with wide cavities which incorporate the bowel lumen. When intestinal obstruction does occur in sarcomatous lesions, it is usually due to intussusception caused by a polypoid intraluminal mass. The luminal narrowing produced by lymphosarcoma is generally insufficient to cause proximal dilatation, tends to be a diffuse process, and, when localized, usually involves a longer segment than in the case of carcinoma. The infiltrating form is associated with diffuse mural thickening and nodular masses which cause separation of adjacent loops. Perforation with fistula may occur. A number of papers have appeared dealing with the roentgen findings in intestinal lymphoma (9, 10). In Wang and Petersen's series of 59 patients with lymphoma of the small intestine, the disease was localized in 26; of 66 patients with lymphoma of the gastrointestinal tract, 50 showed no roentgenologic evidence of splenomegaly (10).

The appendix is the most common site of carcinoids, with the lower ileum next in frequency. Their incidence has been given as 8.3 per cent (11) of small bowel tumors. The most important feature of this group is the low proportion of clinically sig-

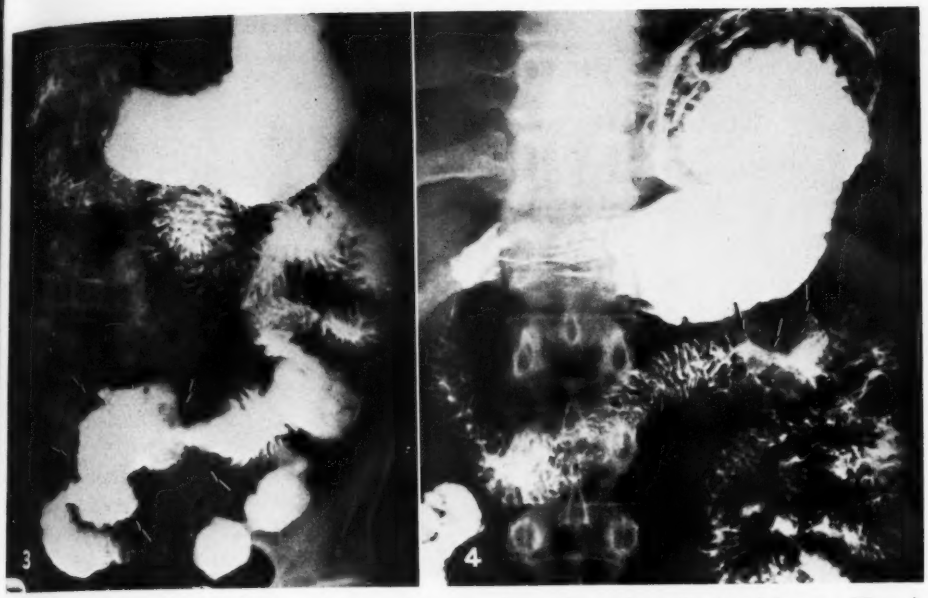

Fig. 3. Case 1. Jejunal carcinoma. A large, rigid, irregular cavity replaces the bowel lumen. There is annular proximal constriction, but there are no overhanging edges, because of the large extramural tumor component. This appearance cannot be distinguished from that of a metastatic lesion.

Fig. 4. Case 3. Jejunal carcinoma. An abruptly demarcated, short segment of mucosal destruction is shown (arrows). There is no proximal dilatation, nor is there sufficient distention of the margins by barium to produce overhanging edges.

nificant lesions. The primary tumor, usually small, appears as a firm, submucosal nodule or a plaque with intact or slightly ulcerated overlying mucosa. There are no cytologic criteria for malignancy, which is best judged on the basis of invasiveness. The neoplasm tends to spread through the wall to the serosa, mesentery, and regional lymph nodes. Hepatic involvement may occur *via* blood-vessel invasion, and cardiac valvular lesions may be associated with extensive metastases (13, 14). Intraluminal growth is rare, though it has been reported as the cause of intussusception (11). Intestinal obstruction may also be caused by annular stenosing growths. It appears, however, that kinking of the bowel at the site where the mesentery is involved is a more frequent mechanism of obstruction (12, 15, 16). Although mucosal ulceration and, therefore, intestinal bleeding is said to be a late and infrequent finding, Bernstein and Chey (3) reported obvious intestinal bleeding in 4 of 6 symptomatic cases.

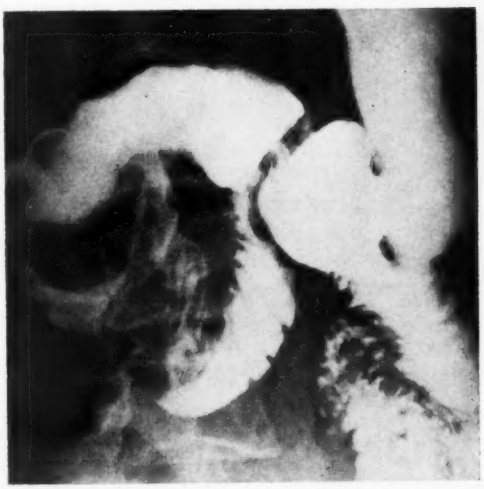

Fig. 5. Case 11. Duodenal leiomyosarcoma. A lobulated filling defect is shown, associated with widening of the lumen.

The group of tumors here reported includes 3 carcinoids, all of which produced partial or complete obstruction. In Cases 4 and 5 the tumor extended to the mesentery and regional lymph nodes, whereas in

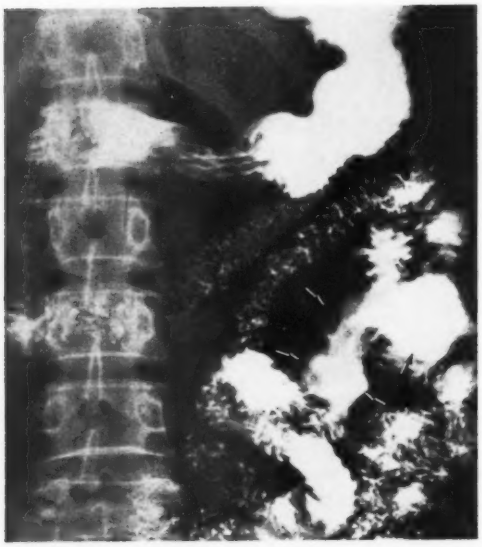

Fig. 6. Metastatic lymphoepithelioma from tonsil. A short segment with mucosal destruction and relative widening of the lumen is shown; there is no proximal dilatation. Note the nodularity of the walls. This cannot be differentiated from lymphoma or Hodgkin's disease.

Case 6, where the tumor was annular, causing marked constriction, the lymph nodes and mesentery were uninvolved. Only in the latter case were the stools guaiac-positive. The carcinoid syndrome, described originally by Thorson (17), was not seen. There were no gross liver metastases in our cases.

*3. Differential Diagnosis:* The demonstration of an organic lesion of the small intestine in a patient with otherwise unexplained symptoms is usually sufficient to warrant surgical exploration even though the radiologist is unable to diagnose its exact nature. Although small-bowel tumors may present a variety of appearances, when certain features are adequately portrayed a specific diagnosis is possible. Of equal importance is the awareness that certain nonneoplastic lesions may be confused with tumors. A number of these which have recently come to our attention deserve discussion here.

In regional enteritis, ulcerated segments,

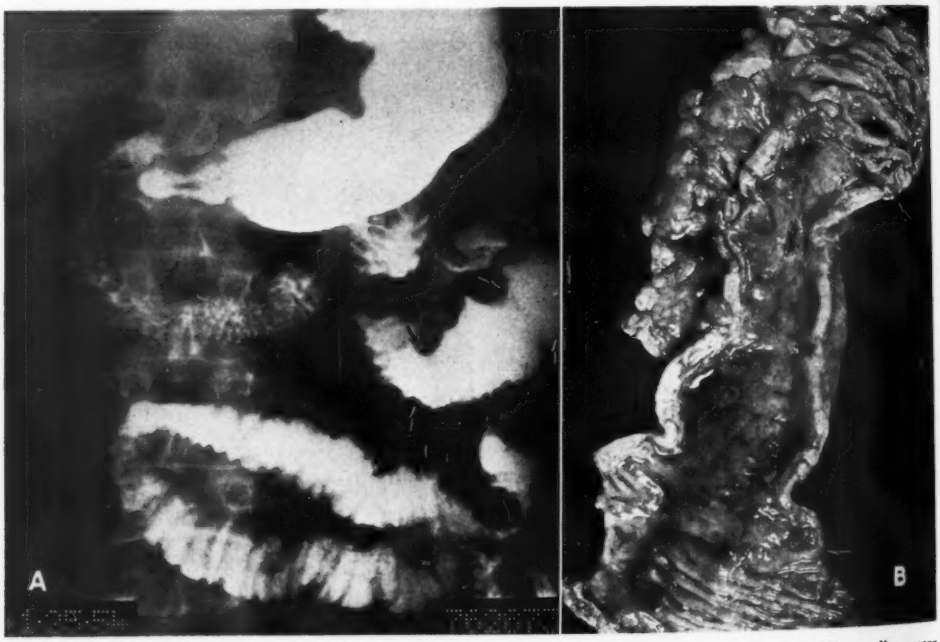


Fig. 7. Nonspecific jejunal ulcer. A. A short, ulcerated segment is shown (arrows). The walls appear nodular and the deformity was constant. There is no significant proximal dilatation. Compare with Fig. 6. B. Surgical specimen. Note the large area of ulceration and abrupt demarcation.

Fig. 8. Invaginated Meckel's diverticulum. A. Ileal filling defect (arrows) on double-contrast study of colon. This defect was apparent on the film of the barium-filled colon.

often partially obstructive, are much longer than in carcinoma or carcinoid. There is associated intestinal spasm, frequently with fistulas, and the thickening of the bowel wall and mesentery causes separation and rigidity of the involved loops. The diffuse, infiltrating form of lymphosarcoma has been confused with regional enteritis, for large mesenteric abscesses may mimic extraluminal tumor masses in the latter and perforation with fistula formation can occur in lymphosarcoma. A differential consideration is that involvement of the terminal ileum is commonly demonstrable in regional ileitis.

A number of writers have emphasized the impossibility of differentiating idiopathic sprue from the diffuse mesenteric form of lymphosarcoma by radiologic means alone (9, 18). The roentgen findings in both conditions may be identical with those in Whipple's disease (19).

Isolated metastases in the small intestine are uncommon and are of interest

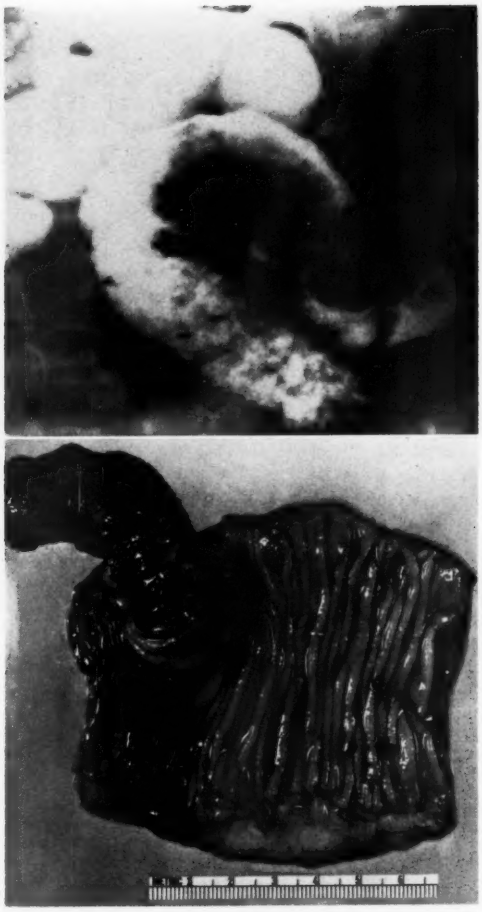

Fig. 8. B. Small-bowel examination. Spot-film with compression, showing a peculiar intraluminal, elongated filling defect. Transverse barium lines proximal to the defect suggest a region of intussusception. Note compression block.

C. Surgical specimen. Mucosal surface of ileum showing edematous mucosa and swollen, invaginated Meckel's diverticulum. Compare with B.

because they may simulate primary growths (Fig. 6). In a series of 26 metastatic tumors analyzed by DeCastro *et al.* (20), 14 were single lesions. When localized mucosal destruction is seen, it usually occurs without luminal narrowing and in this respect resembles lymphoma and Hodgkin's disease. Nodular thickening of the wall adjacent to the ulceration may occur in all these lesions. Although metastatic tumors may cause annular constric-

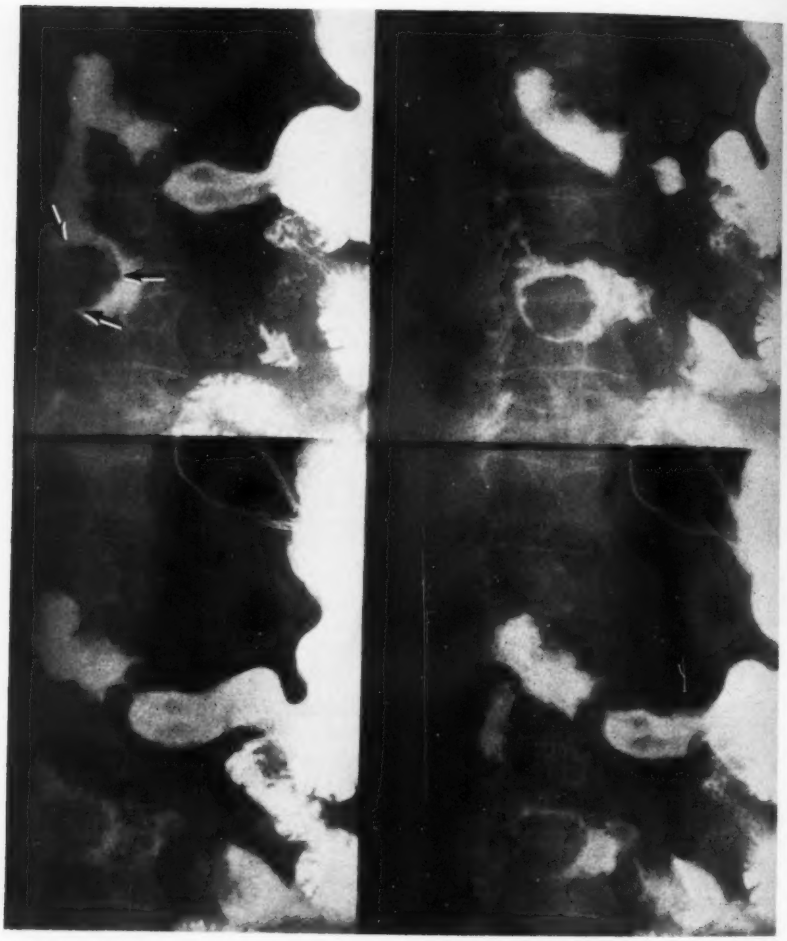

Fig. 9. Intraduodenal gallstone. A smooth, round filling defect is shown (arrows). There is no demonstrable attachment to the duodenal wall. Compare with Fig. 2, A.

tion, intestinal obstruction is more commonly the result of serosal and peritoneal implants which produce adhesions, kinking, and sometimes volvulus; in this respect metastatic implants resemble carcinoids.

Wolf and Marshak (21) described the roentgen features of healing partial segmental infarction of the small bowel. This may be differentiated from an annular tumor because the concentric narrowing occurs with smooth effacement of the mucosal pattern and without irregularity of the lumen, nodularity of the wall, or overhanging edges.

Recently, we observed a case of nonspecific jejunal ulcer which appeared radiologically as an ulcerated widened segment, 6 cm. long, without significant proximal dilatation or overhanging edges (Fig. 7, A). In view of the short segment involved, the relatively abrupt demarcation, and the suggestion of nodularity of the adjacent walls, it is understandable that it was mistaken for a tumor radiologically. A series of 32 cases of nonspecific ulcers of the small bowel has been reported (22). The etiology of this lesion is not clear. In our example there was no histologic evidence that the ulcer was secondary to

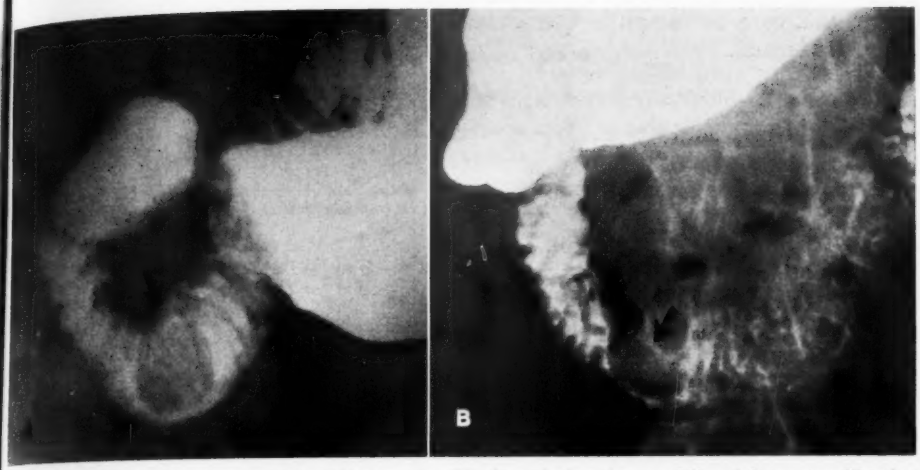


Fig. 10. Gallstone impacted at ampulla of Vater. A. The lateral view shows a filling defect not unlike that in Fig. 9. B. The frontal view demonstrates the intramural character of the lesion; the mucosa at the ampulla is stretched over the stone producing an appearance which is similar to that in Fig. 2, B.

infarction, nor was there clinical evidence to suggest pancreatic islet-cell tumor (23).

Invagination of a Meckel's diverticulum with resultant ileo-ileal intussusception is an uncommon cause of obstruction. Radiographic demonstration of such an intussusception has been published (24). We have recently observed a similar case, which was mistakenly diagnosed as a small-bowel tumor (Fig. 8). Although Meckel's diverticulum should be considered in the presence of distal ileo-ileal intussusception, the findings are nonspecific and cannot be differentiated from an intussuscepting tumor unless the filling defect is identified as the diverticulum. In retrospect, the appearance on one of the spot-films (Fig. 8, B) is highly suggestive of this structure leading an intussusception; most of the films, however, did not show these features, and it is likely that the intussusception underwent spontaneous reduction during the course of the examination. At operation, several days later, the inverted diverticulum was seen to be leading a short ileo-ileal intussusception. Harkins has reviewed the clinical aspects of this condition (25).

The extrusion of a calculus from the gallbladder into the small intestine is not uncommon. In such instances the clinical history is quite variable and often unreliable; air in the biliary tree may not be demonstrated. In the absence of obstruction, the delineation of the filling defect caused by the lucent gallstone may prove confusing if its mobility is not appreciated. In the example shown (Fig. 9), the patient gave a history of having had a retroperitoneal neurofibroma in the region of the distal duodenum removed two years previously. At operation, three days after x-ray examination, a gallstone measuring 2 to 3 cm. in diameter was removed from the third part of the duodenum. Of interest was the fact that the gallstone was not propelled through the small intestine. Inadvertent duodenotomy at the time of previous surgery for the neurofibroma had necessitated gastrojejunostomy because of duodenal narrowing following repair. It is likely that the gallstone did not pass through the small intestine because of this obstruction. A case is cited by Figiel *et al.* (26) in which a gallstone was present in the duodenal bulb for twenty-one days. We have also observed an instance where a calculus was found at surgery to be impacted in the duodenal wall at the ampulla of Vater (Fig. 10). This diagnosis might have been suspected in a normally situated ampulla,

but in this case the ampulla was located lower than usual.

## SUMMARY

The radiologic findings in 17 cases of symptomatic, surgically proved primary small-bowel tumors have been reviewed, and the sources of error analyzed in retrospect. Admittedly uncommon, small-bowel neoplasms are by no means rare and should be suspected when x-ray examination of stomach and colon provides no explanation for persistent intestinal symptoms. Thorough and meticulous roentgen examination of the small intestine is indicated if a small-bowel lesion is seriously suspected.

Radiologic signs are highly dependable in distinguishing between neoplastic and inflammatory lesions; they are often valid, but at times are misleading when identification of particular tumor types is attempted. Some of the conditions which may prove to be problems in the differential diagnosis are illustrated and discussed.

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## SUMMARIO IN INTERLINGUA

### Tumores del Intestino Tenue

Ben que incommun, neoplasmas del intestino tenue es certo non rar e debe esser suspicite quando le examine radiographic del stomacho e del colon non provide un explication de persistente symptomas intestinal. Le exacte e meticulose examine roentgenographic del intestino tenue es indicate si tosto que un lesion del intestino tenue es seriemente suspicite.

Es revistate le constatationes radiologic in 17 casos de tumores primari del intestino tenue. Illos es correlationate con le observationes al operation e con le reportos pathologic. Omne iste tumores esseva operate super le base de symptomas pre-operatori que justificava o deberea haber demandate un examine radiologic del intestino tenue in le presentia del roentgenologia normal de stomacho e colon. Le neoplasma esseva identificate correctemente ante le operation in solmente 6 del casos. In omnes le tumor esseva situate in le duodeno o in le jejuno proximal. Un anormalitate nonspecific esseva recognoscite in 2 del patientes. Isto consisteva in un caso in un obstruction mechanic e in le altere in un anormalitate del configuration del intestino tenue.

Le signos radiologic es multo fidel in le differentiation inter lesiones neoplastic e lesiones inflammatori. In le essayo de identificar le typo specific de un tumor particular, ille signos—ben que frequentemente valide—deveni a vices illusori. Es illustrate e discutite certe conditiones que a vices deveni problematic in le diagnose differential. Istos include enteritis regional, sprue idiopathic, metastases isolate, infarcimento segmental partial durante le processo restabilitori, non-specific ulcere jejunal, invagination de un diverticulo de Meckel con resultante intussusception ileo-ileal, e extrusion de un calculo ab le vesica biliari.

# Retroperitoneal Fibrosis

## An Anatomic and Radiologic Review with a Report of Four New Cases and an Explanation of Pathogenesis[1]

JOSEPH DINEEN, M.D., THANE ASCH, M.D., and JOHN M. PEARCE, M.D.

SINCE ORMOND (22) in 1949 first described 2 patients with a chronic inflammatory disease characterized by fibrosis in the retroperitoneal area, 37 similar cases have been documented. The condition was originally called periureteral fibrosis because the major symptoms resulted from ureteral obstruction. A greater knowledge of the structural changes involved indicates that the designation retroperitoneal fibrosis, although broader, is also more accurate. In the majority of the cases the diagnosis was made by surgical exploration and microscopic examination of excised tissue. In 1957 Talbot and Mahoney (30) presented an excellent review of 16 of these cases with full postoperative follow-up. Two necropsies confirmed the basic nature of the disease. These authors added one case of their own. In 1958 Hackett (9) reported 2 cases and reviewed 22. Other examples have been well described (1, 3–8, 12, 13, 15–21, 24, 26–29).

### CASE REPORTS

CASE I: F. O., a 57-year-old white man, had been treated since 1935 for pulmonary tuberculosis. He also had an enlarging thyroid. In May 1950 he began to experience upper abdominal discomfort and lost 8 pounds. He was admitted to Bellevue Hospital, where he lost 10 additional pounds, and in July of 1950 an exploratory laparotomy revealed a retroperitoneal mass which was thought to be an inoperable malignant tumor. Biopsy, however, was interpreted as showing chronic inflammation. There were marked fibrosis of the retroperitoneal fat and infiltration with lymphocytes, plasma cells, and eosinophils. Because of weakness and dyspnea, with abdominal swelling and edema, the patient was admitted to the New York Hospital in October 1951. Urea nitrogen levels in the blood, urinalysis, and an excretory pyelogram were normal. In November a peritoneal tap yielded fluid containing cells rated cytologically as Papanicolaou Class V. The patient grew progressively worse and required frequent pericardial taps and diuresis before death.

Autopsy revealed a large mass in the retroperitoneal area, extending from deep in the pelvis up about the aorta into the chest and to the heart, involving the epicardium, particularly the atrioventricular groove. The "tumerous tissue" also encased the coronary arteries. The adventitia of the thoracic aorta was completely replaced by collagenous tissue which extended to and partially replaced the pleura as well. In the lungs and kidneys this unusual fibrotic process followed the course of the arteries and arterioles from the aorta. The collagenous tissue spread out and involved the branches of the celiac axis. In addition to the scirrhous fibrosis, there were many infiltrating lymphocytes and foamy or lipid-laden macrophages. Some cells with large, dark nuclei and vacuolated cytoplasm were interpreted as representing primitive fat cells, and the final postmortem diagnosis was fibroliposarcoma.

CASE II: D. U., a 41-year-old white man, was admitted to the hospital in February 1955 with a six-month history of left flank pain, nocturia, frequency, and a 55-pound weight loss. An intravenous pyelogram revealed complete obstruction to the middle third of the left ureter. Retrograde pyelography demonstrated a fusiform narrowing, probably due to an extrinsic lesion in this area. At operation the middle third of the ureter was found to be embedded in a firm mass of retroperitoneal tissue for a distance of 7 cm. The mass itself extended from the pelvic brim to the diaphragm and diffused out laterally also across the midline. Biopsy disclosed only a chronic inflammatory process with marked fibrosis and infiltration of lymphocytes, plasma cells, and foamy histiocytes in the retroperitoneal fat. A left nephrostomy was performed. Following this, the patient did well until April 1955, when right upper quadrant pain, nausea, and vomiting developed. In June 1955, an excretory pyelogram revealed a nonfunctioning right kidney, and a right nephrostomy was done. Since that time the patient has been well. He now has prompt function bilaterally and only minimal caliectasis. He has regained all his lost weight. (Figs. 1 and 2).

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Fig. 1. Case II. A. Initial left retrograde pyelogram showing 5-cm. segment of narrowed ureter. The gradual tapering of the ureter proximal and distal to the defect is characteristic. Retrograde studies demonstrate the lesion with greatest clarity.

B. Four months later, right-sided symptoms prompted retrograde study, which demonstrates a defect similar to that shown in A. Note proximal ureteral tortuosity and sharp medial angulation, resulting in a medially placed ureter.

CASE III: W. M., a 42-year-old Negro, was admitted in February 1954 because of four days of anuria. He gave an eight-month history of bilateral flank pain and a 20-pound weight loss. An excretory pyelogram disclosed nonfunction bilaterally. Retrograde pyelography revealed grade 3 left hydronephrosis and a grade 4 hydronephrosis on the right. Both ureters showed medial deviation and a 5-cm. area of narrowing at the middle third. At laparotomy, a pancake-like retroperitoneal mass was found to extend from the upper ureters into the pelvis, also encasing the aorta and vena cava. The left ureter was liberated and transplanted and a left nephrostomy was performed. Microscopically the excised tissue again showed marked scirrhous fibrosis and infiltration of lymphocytes, plasma cells, and eosinophils. This process was intimately associated with fat, and again there were many lymphocytes and macrophages. In May the right side was also explored and a similar process discovered. The right ureter could not be liberated and nephrostomy was done. Now, four years later, the patient is doing well. There is no function on the left and grade 1 hydronephrosis and prompt function are present on the right (Figs. 3–5). We assume that there had been too much initial renal destruction on the left for that side to function even after liberation of the left ureter. Why the right kidney continues to function is not clear; some release of fibrous tissue may have resulted during the operative attempt to free the right ureter.

CASE IV: J. D., a 64-year-old Negro, was admitted in December 1958 with an eight-month history of weakness, a 25-pound weight loss, and anemia. The urine contained occasional red blood cells and five white cells per high-power field. The blood urea nitrogen was 13 mg. per cent and the hematocrit 31. An intravenous pyelogram revealed a grade 2 right hydronephrosis. Retrograde pyelography disclosed medial deviation of the right ureter with obstruction to the middle third. At laparotomy the lower third of the right ureter was found, encased in a white avascular sheet which extended over the vena cava. The ureter was transplanted.

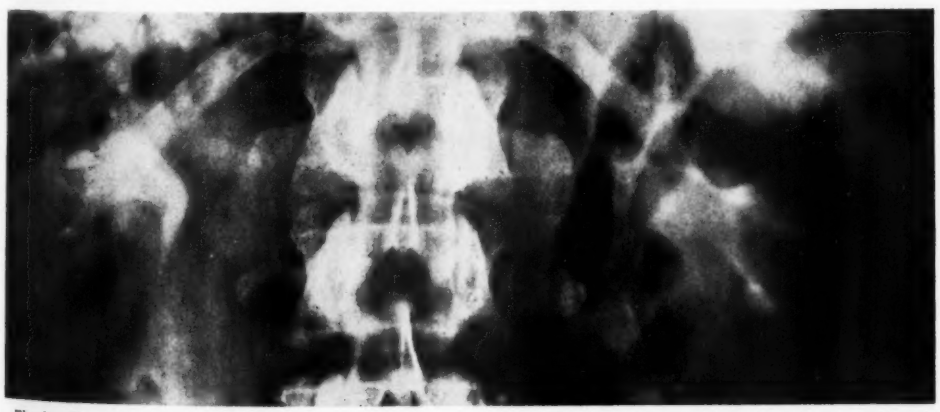


Fig. 2. Case II. Intravenous pyelogram obtained four years after the retrograde studies shown in Fig. 1. This demonstrates prompt function bilaterally with minimal hydronephrosis. Note well defined psoas margins, which are not often obliterated in this condition, probably due to the thin sheet-like extent of the lesion. The long follow-up in this patient establishes the benign nature of this disease when definitive surgery is initiated early.

Fig. 3. Case III. A. Initial right retrograde pyelogram demonstrating 5-cm. segment of narrowed ureter. A previous intravenous pyelogram had shown bilateral nonfunction. Twenty-five per cent of these patients present with anuria.

B. Initial left retrograde pyelogram showing 6-cm. narrowed segment opposite bodies of L-4 and L-5, a characteristic location. As in the majority of such patients, retrograde catheters could be passed up both ureters.

Sections of the encasing white tissue examined microscopically disclosed marked scirrhous fibrosis with many lymphocytes, plasma cells, and eosinophils infiltrating the fat. There were many lipid-laden macrophages. The ureter was not splinted at this procedure and no nephrostomy was performed. Postoperative recovery was rapid. Five months later the left ureter was obstructed and the patient was readmitted. At exploration a similar retroperitoneal lesion was discovered on the left side. The ureter was liberated and transplanted. No splinting and no nephrostomy was performed. A preoperative intravenous aortogram was normal (Figs. 6–8).

## DISCUSSION OF CASES

Cases II, III, and IV are typical manifestations of retroperitoneal fibrosis both clinically and pathologically. In Case I a diagnosis of fibroliposarcoma was made at postmortem examination. In retrospect, however, it becomes apparent that it is extremely difficult to recognize tumor cells and to differentiate them from the obvious macrophages and other leukocytes that are present in great numbers. Certainly field after field of this extensively studied necropsy material is quite similar to the retroperitoneal fibrosis in our other cases. The extensive and diffuse growth pattern of the fibrotic tissue is unlike that of a fibrosarcoma or a liposarcoma. As in our other non-neoplastic cases, there is no single large tumor mass, but rather flat, plaque-like sheets of tissue. On the other hand, the extension of the fibrous tissue along

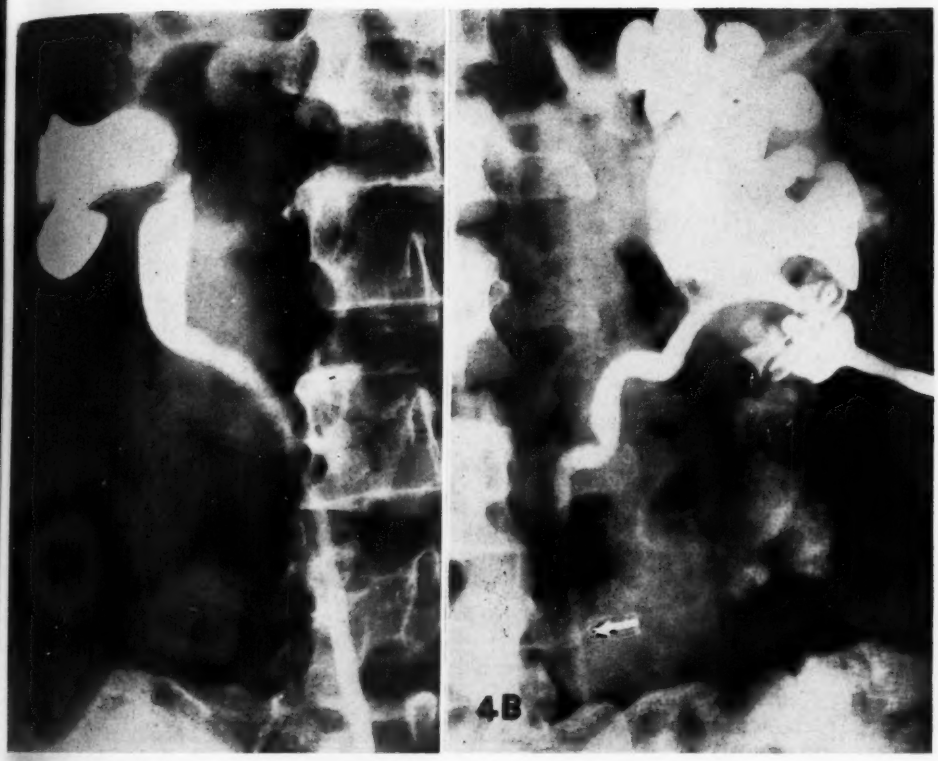



Fig. 4. Case III. A. Right retrograde pyelogram obtained twenty-two months after studies reproduced in Fig. 3, following removal of nephrostomy tube. The caliber of the previously narrow segment is distinctly increased, although the right side could not be liberated at operation. A left intravenous pyelogram revealed poor function. Blood urea nitrogen is now 26 mg. per cent (on admission 120 mg. per cent).

B. Left antegrade pyelogram study four years after admission. Note persistent narrowing with advanced hydronephrosis. The left ureter had not been liberated.

Fig. 5. Case III. Intravenous pyelogram four years after admission. Prompt functioning hydronephrosis on right side (nonfunctioning left kidney). Left nephrostomy now drains approximately 300 c.c. of urine daily.

the courses of the great vessels entering the kidney and lung is unusual and was not seen in our other cases of retroperitoneal fibrosis. It is significant, also, that in this case there was no ureteral obstruction and no hydronephrosis. A remarkably similar case has recently been reported (8).

## TERMINOLOGY

Various names have been assigned to this condition, including "periureteric fibrosis," "periureteritis obliterans," and "periureteritis plastica." The term, "periureteric fibrosis," while it indicates that the major involvement is almost always

Fig. 6. Case IV. Initial right retrograde pyelogram. The involved segment of ureter appears to have numerous small diverticula associated with the wall. This appearance has not been previously described. Ureteral diverticula have been reported (11) but not in association with narrowing or the characteristic fibrosis observed here.

Fig. 7. Case IV. Inferior vena cavagram. Note involvement of lateral wall of this vessel, confirmed at operation. The great vessels of the abdomen are often enveloped by this disease and rarely symptoms of lower extremity edema and claudication have been reported.

ureteral, neglects the occasional vascular consequences of the disease. Involvement of the great vessels has resulted in edema of the lower extremities (4) (vena cava) and claudication phenomena (4) (iliac arteries). Evidence of great vessel involvement has been well demonstrated radiographically (9 and 26) by opaque injection, and some involvement of these vessels has almost always been evident at surgical exploration. Periureteritis plastica is a rare disease (5 cases reported) (10) which is characterized by a peculiar marked 1- to 2-cm. thick hyperplasia of loose areolar tissue surrounding the ureter and imparting a garden-hose appearance. Because of the definite gross and microscopic differences between it and retroperitoneal fibrosis, the latter must be considered a separate disease. We feel that the above considerations militate in favor of the term retroperitoneal fibrosis until the etiology and pathogenesis are more clearly defined.

## ETIOLOGY

Several etiologic theories have been suggested. Coppridge (5) described necrosis of fat cells with liberation of fat droplets into the intracellular spaces and resultant necrosis of surrounding cells simulating a foreign body granuloma. Amselem (1) advocated surgical trauma as a cause. Chisholm (4) stated that the retroperitoneal spaces are affected *via* lymphatics draining the intestine. Hackett (9) believed that the condition results following organization of fibrin after bleeding initiated by trauma. Surgical and

other trauma, including intra-abdominal inflammatory conditions, have been associated with many cases but not with all of them, and retroperitoneal fibrosis has been reported after extravasation of contrast material following retrograde study (14). The specific etiology is yet unknown.

## CLINICAL FEATURES

In the reported cases, including our own, the patients' ages have ranged from twenty-three to sixty-nine years, the average being forty-four, with 60 per cent between forty and sixty. There were 34 men and 9 women. The symptoms are remarkably uniform. Months of ill health, with anorexia, nausea, and vomiting, are associated with vague abdominal pain, frequently marked weight loss, and flank pain, often with a testicular component. Occasionally sudden complete anuria with only vague prior symptoms, impels the patient to seek medical advice. The disease is bilateral to some degree in the overwhelming majority of patients. Unilateral involvement is usually promptly followed by the appearance of contralateral symptoms.

Physical examination is unrewarding. Tenderness is rarely elicited, and a palpable mass was noted in only two instances (17, 24). Fever is not common. Laboratory studies show anemia in 30 per cent of patients. The white blood count and sedimentation rate are not significantly elevated. Red and white blood cells are frequently seen in the urine.

## PATHOLOGY

The gross lesion is a dense, indurated flat mass up to 2 inches thick, white or yellow in color, usually completely incorporating the ureter for a variable extent but not invading the wall. This plaque of fibrous tissue can involve the great vessels and cross the midline to involve the contralateral ureter. According to Hackett (9), its boundaries are very definite. It has extended above the hilus of the kidneys, but only on three reported occasions. In one patient involvement of the extrabiliary ducts resulted in jaundice (26). In another case the adrenals, pancreas, and diaphragm were adherent (24), and in our Case I the diaphragm was traversed and the heart was involved. Lateral extension more than 1 cm. beyond the ureters has not been recorded. Below, the mass fades out over the pelvic brim. In 2 cases it invaded the pelvis.

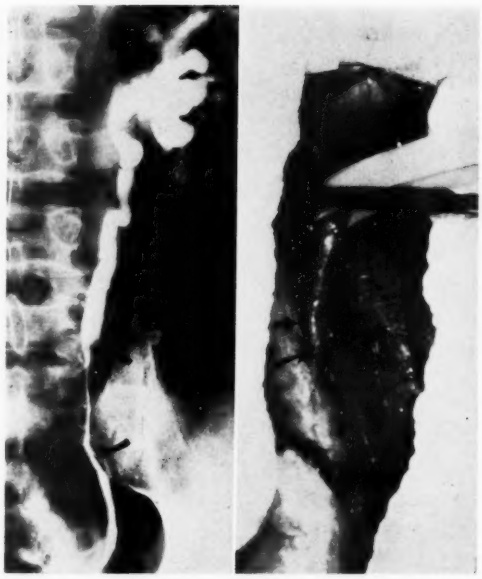
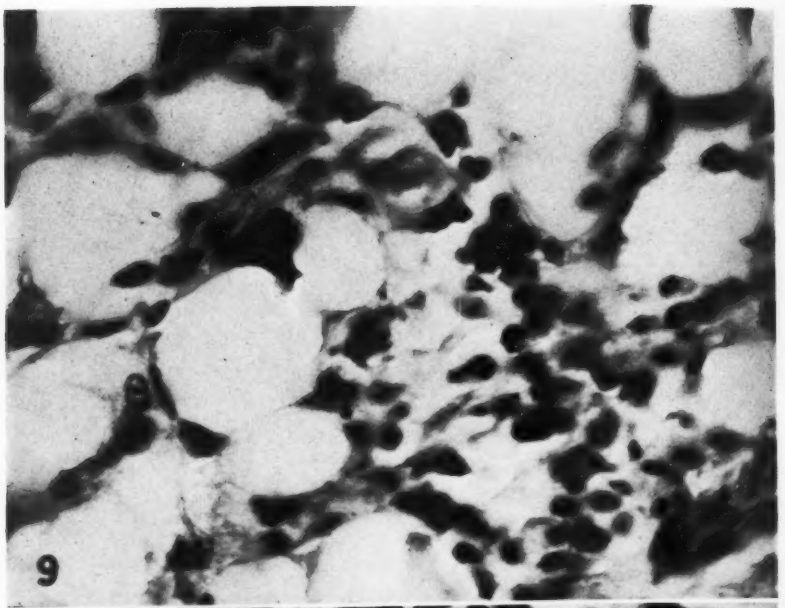


Fig. 8. Case IV. Five months after the transplantation of the right ureter, recurrence of symptoms prompted left retrograde pyelography. The pyelogram and the operative specimen are shown for comparison. The Penrose drain encircles a dilated, redundant, but not narrowed proximal left ureter from which a thick encircling layer of fibrous tissue extending to the kidney hilus was easily stripped free. The clamp is fixed on the freed portion. Medially a thick fibrous plaque was adherent to the aorta and left iliac artery. The distal ureter is seen to plunge into a fibrous mass which corresponds to the area of narrowing on the radiograph. This was dissected free with more difficulty, and was found to be both edematous and indurated. The lesion faded away at the pelvic brim. Intravenous aortography was normal.

Microscopically (Figs. 9–13) the primary and anatomical alterations in this disease appear to be an inflammation and necrosis of the retroperitoneal and periaortic fat. Following the destruction and disappearance of fat, there is an overgrowth or replacement by fibrous tissue. The amount and density of fibrosis varies from case to case and probably from place to place in



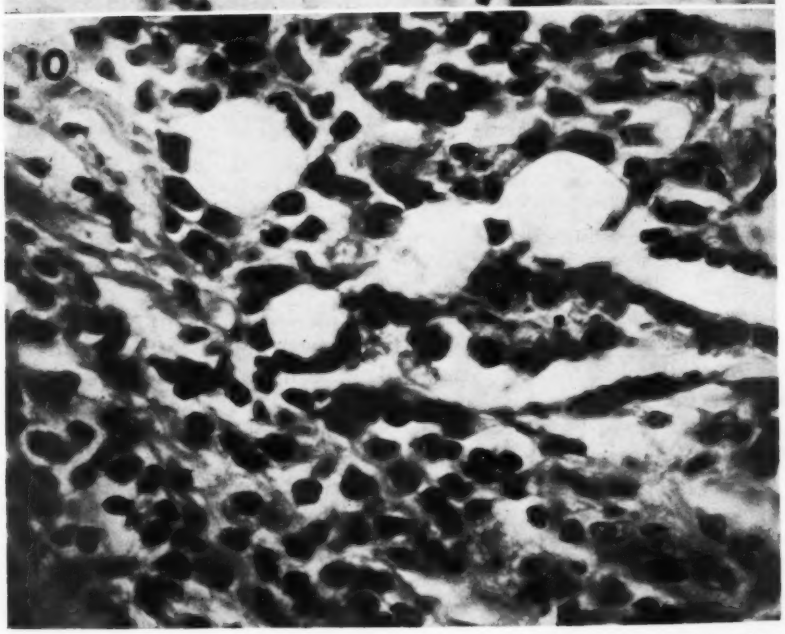




Fig. 9. Case IV. An area in the retroperitoneal tissues in which fat cells still predominate but in which the infiltration of leukocytes, phagocytes, and early fibroblastic proliferation are evident. Hematoxylin and eosin. ×730

Fig. 10. Case IV. Progression of the lesion. Fibrosis and leukocytic infiltration predominate, but fat persists. Each fat cell is ringed by leukocytes and each is shrunken, the magnification here being the same as in Fig. 9. Hematoxylin and eosin. ×730

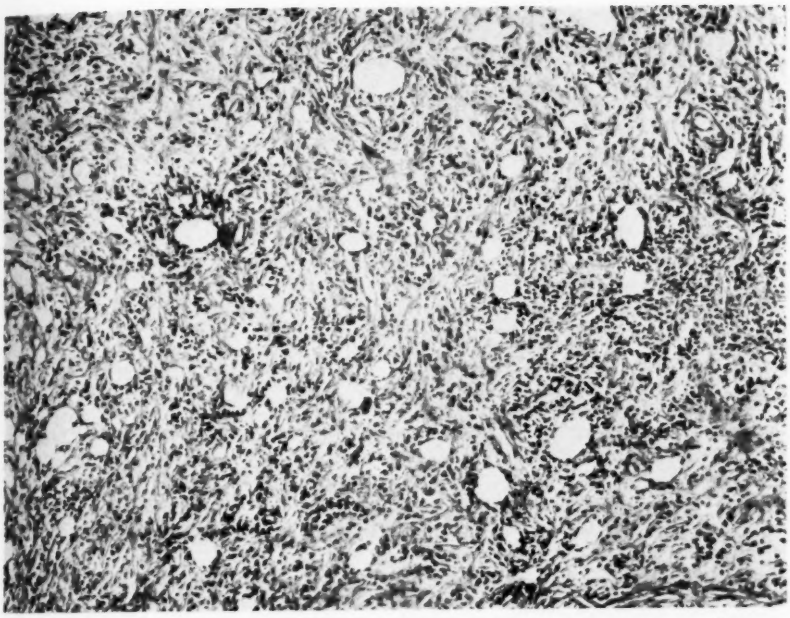


Fig. 11. Case III. Extensive fibrosis in an area near the ureter. Leucocytes are still numerous and tend to concentrate around the remaining fat cells. Hematoxylin and eosin. ×100

any one patient. The earliest lesion is presumably a reaction quite similar to that seen in Weber-Christian's disease or nonsuppurative panniculitis. It also closely resembles sclerosing lipogranuloma, described as a granulomatous reaction occurring in the subcutaneous fat after injuries of various types (5). In some of our biopsied material, notably in Case IV, there are areas in which considerable fat remains and there is still a close resemblance to the Weber-Christian reaction. As the lesion progresses, the fibrosis becomes greater. At first there are many macrophages, eosinophils, and plasma cells among the fat cells, but later the fibrous tissue becomes more hyaline and less cellular. Multinucleated cells are rare. Many of the macrophages contain fat vacuoles. The structures in the involved retroperitoneal areas are surrounded by fibrous tissue, blood vessels, lymph nodes, and nerves, and the ureters are encased in the dense mass of collagen. In many of the smaller vessels the lumen is obliterated and replaced by fibroblasts, but although there are occasional leukocytes in the walls of these arteries, the lesion appears to be secondary to the surrounding fibrosis rather than an arteritis that has produced fibrosis by ischemia. Although the walls of the ureter are surrounded by the fibrous tissue, they remain distinct from it and can often be dissected away from it without great difficulty. The lumina are irregularly narrowed by the disease.

### RADIOLOGICAL DIAGNOSIS

The appearance is characteristic but not specific. The salient features are demonstrated by retrograde pyelography. Hydronephrosis is evident. The proximal ureter is dilated and tortuous and then swings medially by sharp angulation. The ureter tapers gradually to a fixed stenotic segment which varies from 3 to 6 cm. in length and which usually resides opposite the body of the 4th and 5th lumbar vertebrae. Normal ureteral caliber is then gradually resumed. A unique finding in one of our patients (Case IV) was the presence of numerous small sacculations in

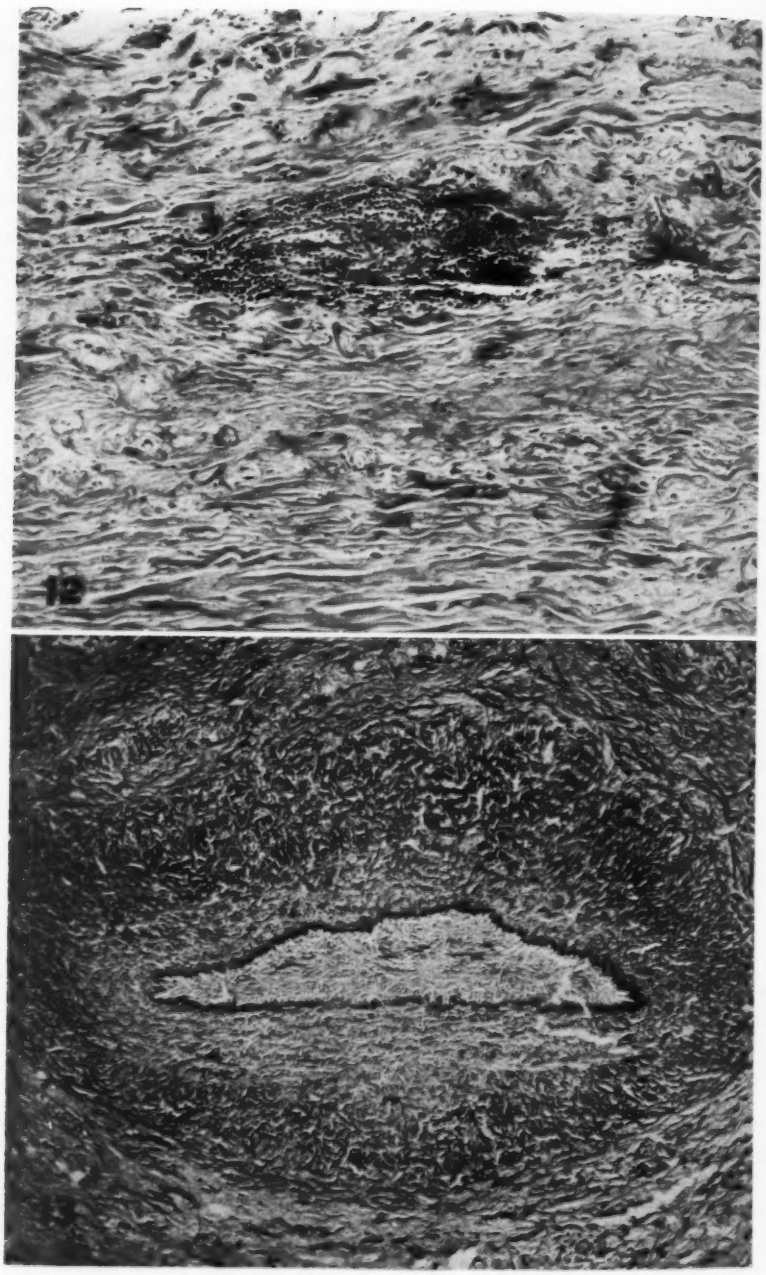


Fig. 12. Case II. Fat has disappeared entirely, leaving only hyaline fibrous tissue containing clumps of lymphocytes. Hematoxylin and eosin. ×100

Fig. 13. Case II. An arteriole in a plaque of retroperitoneal fibrosis that has been surrounded by the fibrosing tissue. The wall has been thickened by the participation of the adventitia in the proliferative process, but the muscularis and internal elastica are intact. The lumen is filled and occluded by pale fibrous tissue. Weigert-van Gieson. ×40.

the region of involvement. Stössel (29) reported one case in which ureteral varicosities, presumably the result of the disease, produced in the ureteral wall small cystic defects which resembled ureteritis cystica. Numerous conditions have produced analogous radiographic appearances. Local or metastatic spread from cancer in the bladder, ovaries, cervix, testes, breasts, and gallbladder have been reported, as well as lymphomas of different types with origin in the retroperitoneal space (Fig. 14). Retrocaval ureter mimics the appearance to a certain degree.

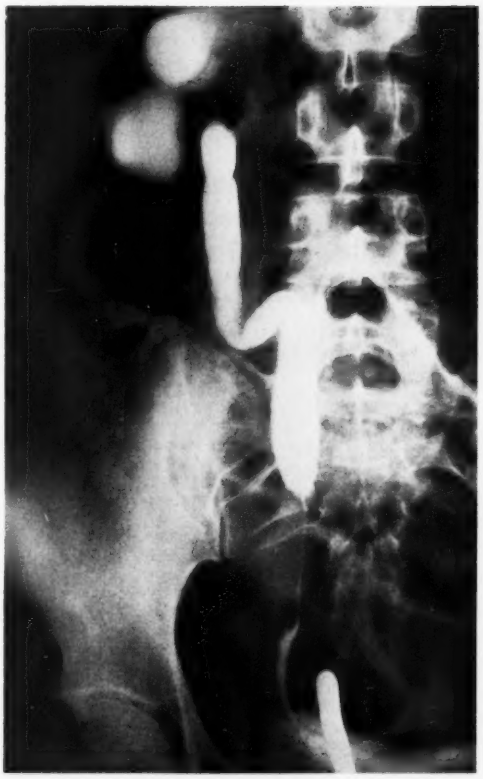


Fig. 14. Differential diagnosis: Carcinoma of the cervix and lateral pelvic extension in a 34-year-old Negress. The appearance simulates retroperitoneal fibrosis, although it is too low in the pelvis. There is more narrowing than usual, and the tapering is not gradual.

### TREATMENT AND PROGNOSIS

It must be emphasized that this is a benign disease and that surgery should not be delayed. The reported deaths have been due to late diagnosis, permitting the production of intractable uremia or advanced renal destruction secondary to obstruction and infection. In most cases the ureter could be stripped away from the offending fibrous plaque with relative ease. In those cases where ureteral freedom was difficult to achieve, there was often enough proximal ureteral tortuosity to permit primary anastomosis. The fact that the disease is almost consistently bilateral necessitates conservative corrective therapy rather than nephrectomy. The prognosis is excellent if renal function has not been too severely compromised, and no recurrences have been reported. Radiation therapy has been utilized in 3 instances, with favorable results in 2. In 1 case (9), radiation was the only therapy offered, and complete remission followed. Antibiotics and steroids have also been used. However, the small number of cases so treated does not warrant a definite conclusion concerning the efficacy of nonsurgical treatment.

### SUMMARY

1. Four cases of benign idiopathic retroperitoneal fibrosis are presented, bringing the total number of reported cases to 43.

2. The lesion is identical histologically with sclerosing lipogranuloma and in its early phase bears a close resemblance to Weber-Christian's disease or nonsuppurative panniculitis.

3. The lesion presents as a fibrous plaque which envelops one or both ureters and the great vessels of the abdomen. Involvement of other areas is rare.

4. Clinically, weight loss and flank pain are almost universal symptoms, and the disease usually progresses to bilateral involvement somewhere in its course.

5. Surgical, traumatic, and infectious etiologies have been suggested.

6. The treatment of choice is early surgery, including ureteral lysis and ureteral transplantation with or without nephrostomy and splinting of the ureter.

7. The characteristic radiographic features are demonstrated by retrograde pyelography.

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*(Pro le summario in interlingua vider le pagina 398)*

# The Role of the Ileocecal Valve in Large Bowel Obstruction

## A Preliminary Report[1]

LEON LOVE, M.D.

SINCE 1932, when Wangensteen (1) published his report of the successful use of suction therapy for the relief of intestinal obstruction, interest has steadily grown in both the roentgen and clinical diagnosis of colon obstruction (2–5).

### THE PROBLEM

Most early reports of large bowel obstruction stated that the ileocecal valve was competent, and that the pressure was insufficient to overcome its resistance. Many radiologists, however, have observed as much as 90 per cent reflux of barium into the terminal ileum during colon examinations (6). Buirge (7) believed that shortness of the lips of the valve account for its incompetence and reported significant anatomic variations indicating an incompetent valve mechanism in 46 per cent of autopsied cases. Rendleman *et al.* (8) conducted *in vivo* experiments on dogs in which the ascending colon was occluded by a clamp 10 to 12 cm. above the ileocecal valve and noted at what point water trickled through a slit in the terminal ileum. Their observations ranged from complete incompetence of the valve to competence at a level of 28 cm. water pressure. The average pressure required to overcome the resistance of the valve was about 13.4 cm. of water. Resistance to reflux increased up to 19 cm. of water after death.

These same investigators conducted barium-enema examinations on 25 patients and recorded the pressures necessary to overcome valve resistance by means of a U-tube water manometer connected to the enema tubing. Reflux occurred in 36 per cent of patients at 25 cm. or below, in 84 per cent at 50 cm. or below, and in 96 per cent at 90 cm. or less. Dennis (9) determined the intraluminal pressure in 34 cases of large bowel obstruction at the site of transverse colostomy and found that the average pressure was 14 cm. and the highest recorded 34 cm. of water.

Fifty-two cases of large bowel obstruction were divided by Dennis into four groups: (*a*) gas present only in the large bowel; (*b*) gas in the terminal ileum; (*c*) definite amounts of gas in the small-bowel but predominating large bowel distention; (*d*) gas chiefly in the small bowel, less evident in the large bowel. In two-thirds of his series there was some small bowel distention; one-third had real ileal distention, and in 8 per cent distention of the small bowel predominated.

An analysis of these two sets of data suggests that sufficient pressure will result from obstruction in the large bowel to overcome resistance of the ileocecal valve in up to 30 per cent of patients.

According to some reports, the majority of large bowel obstructions showed gas strictly confined to the colon (2, 5, 10). Many others, however, including Dennis, cited above, have noted accompanying distention of the small bowel (9, 11, 12).

Small bowel distention may be due to a number of factors: residual stasis (9); associated reflex ileus due to a toxic reaction to the large bowel obstruction; adhesions of the large bowel lesion, mechanically obstructing the adjacent loops of the small intestine; incompetence of the ileocecal valve (9).

In colonic obstruction there are two basic mechanisms influencing the distribution of gas in the large and small bowel (7, 18, 19). (*a*) A competent ileocecal valve permits continued entrance of small bowel contents into the large bowel and prevents retrograde reflux (*closed loop*).

[1] From the Department of Radiology, Cook County Hospital, Chicago, Ill., Irvin F. Hummon, M.D., Director. Presented as a Scientific Exhibit at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959. Accepted for publication in January 1960.

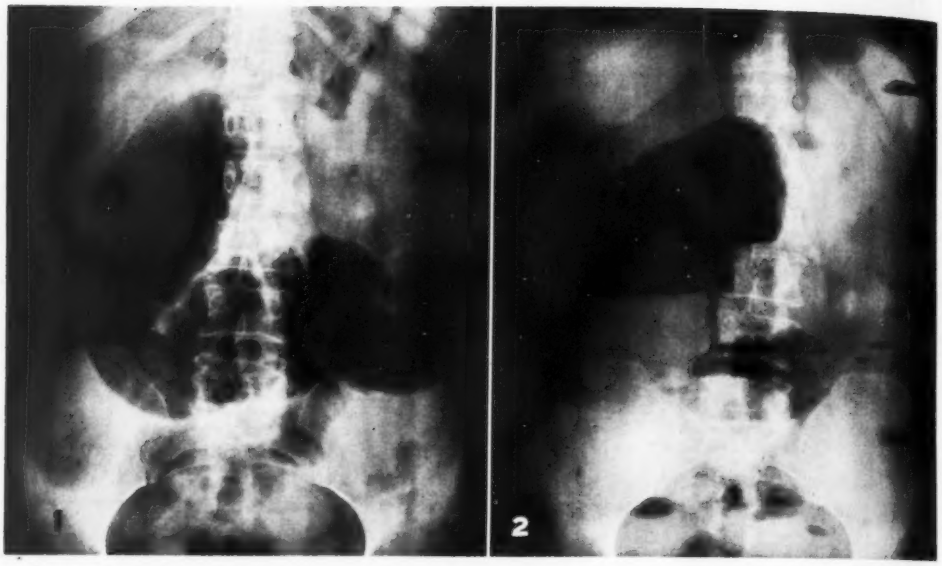

Fig. 1. Case I (Type IB): Anteroposterior view. A markedly dilated loop of transverse colon is seen, with no air in the descending colon. There is some small bowel distention in the midabdomen.
Fig. 2. Case I: Upright film. A long air-fluid level is seen in the right colon. Multiple small bowel levels are seen throughout the abdomen.

Should the obstruction continue, the fluid- and gas-filled cecum and the tightly closed ileocecal valve will act as a cause for secondary obstruction in the small bowel, with consequent distention (3, 19). (*b*) With a completely incompetent ileocecal valve, the gas in the large bowel is readily decompressed into the small bowel or the increased pressure in the large bowel, in cases of obstruction, is sufficient to overcome the resistance of the valve.

### X-RAY INTERPRETATION

(A) In the *classical case* of large bowel obstruction the cecum is markedly dilated, with the remainder of the colon distended down to the level of stenosis (2). The only small bowel distention demonstrated is that due to secondary causes, as listed above. The greater dilatation of the cecum is explained by the fact that the cecal walls are anatomically the thinnest and most easily distensible portions of the large bowel (5). The x-ray findings in this group are as follows:

1. The *anteroposterior film* shows a dilated, thin-walled cecum and dilatation of the large bowel to the point of obstruction. The cecum is the first area to show evidence of distention, and the immediate prestenotic segment is the last to become dilated (3).

2. *Lateral decubitus and upright films* demonstrate long fluid levels in the cecum, ascending colon, and possibly in the descending colon. A tumor is occasionally visualized as a soft-tissue mass.

(B) If the *fluid-filled cecum and a competent ileocecal valve* act as a cause of secondary obstruction, a markedly dilated colon will be noted down to the point of obstruction. In this variety, one might expect the cecum to reach its largest size. Perforation of the thin-walled cecum may occur, presenting as a surgical emergency (13).

1. The *anteroposterior film* shows a markedly dilated colon with a dilated cecum and thinned-out walls, and varying degrees of small bowel dilatation which may even resemble a small-bowel obstruction.

2. *Upright and lateral decubitus films* again demonstrate fluid levels in the cecum, ascending colon, and descending

colon. Fluid levels are also seen in the small bowel.

CASE I (Figs. 1–3): M. H., a 59-year-old Negro female, entered Cook County Hospital on Feb. 18, 1959, complaining of abdominal swelling of one month duration. She had experienced occasional episodes of lower abdominal pain of a crampy and intermittent nature, lasting for a few minutes several times daily. Two days prior to admission bowel movements ceased and "gas didn't pass." During this two-day period the patient vomited three times after eating. She had lost 5 pounds in six months.

*Physical Examination:* The blood pressure was 130/90, temperature 99°. The abdomen was distended. The liver, kidneys, and spleen were not palpable. The bowel sounds were hypoactive, with an occasional high-pitched squeak.

*Laboratory Findings:* The white cell count was 4,800; hemoglobin 82 per cent; urine, normal.

*Roentgen Examination: Anteroposterior films* revealed a markedly dilated transverse colon. The cecum appeared large and fluid-filled. An occasional loop of small bowel was seen.

*Upright and lateral decubitus views* showed a long fluid level in the cecum.

*A barium enema study* demonstrated an obstructive filling defect in the mid-descending colon.

*At surgery*, the cecum was found to be perforated, with spillage of feces throughout the abdomen.

The sequence of events in this case would indicate that cecal thinning due to distention occurred, with subsequent rupture of the cecum. Visualization of the small intestine on the film study was probably due to a secondary obstruction as a result of the large cecum and tight valve.

(C) *Incompetence, or Relative Incompetence of the Valve:* It has been shown pathologically that the muscularis of the colon will hypertrophy in the presence of obstruction (14). Thus, it can be anticipated that the cecum also will hypertrophy if given sufficient time for relief of distention through backflow into the small bowel. Under these circumstances, the expected x-ray findings should be as follows:

1. *The anteroposterior view* reveals only moderate distention of the colon to the level of the lesion. The cecum is not overly enlarged, and thickening of the wall and haustra are present. The walls of the colon appear thickened when contrasted with the properitoneal fat lines. The small bowel is rather prominent.

Fig. 3. Case I. Barium enema study, revealing a complete obstruction in the proximal descending colon. The cecum measures approximately 10 cm. and its wall appears thinned out, with no haustral markings.

2. *Upright and lateral decubitus films* may reveal long fluid levels in ascending colon, cecum, and occasional small bowel loops. As the changes here are the result of backflow rather than actual obstruction, the appearance is not usually that of a small bowel obstruction. Dilatation of the colon would not be expected to approach that found with a competent ileocecal value.

There is seldom more than a limited opportunity to examine the ileocecal valve and cecum, as surgery is usually only for decompression, consisting either of a transverse colostomy or cecostomy, with no exploration of the valve itself, and with limited abdominal exploration. Several of our surgeons have reported the occurrence of a markedly thickened cecum at the time of decompressive cecostomy for sigmoid obstruction, which originally prompted this investigation. A one-stage surgical procedure for right-sided obstructive lesions does present an opportunity to

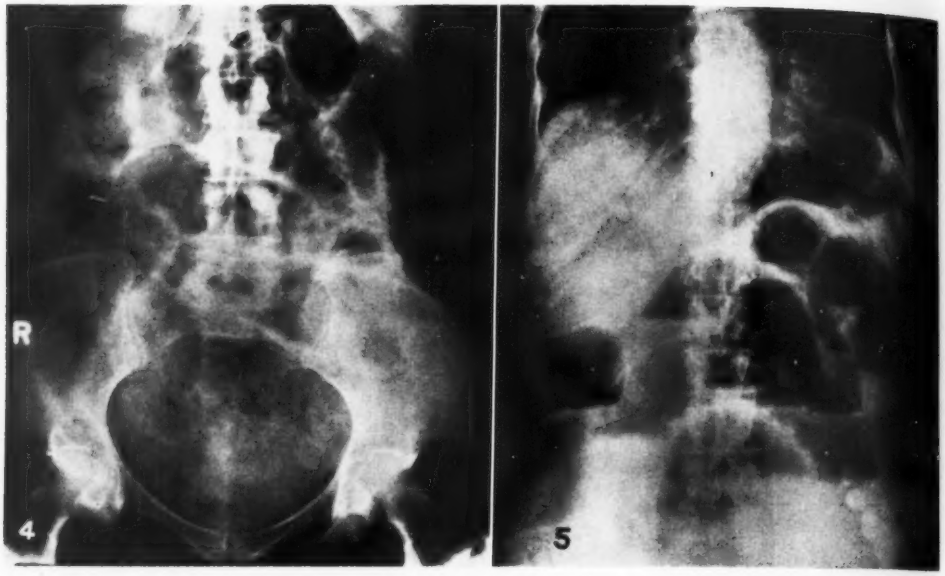


Fig. 4. Case II (Type II): Anteroposterior film showing multiple loops of distended small bowel extending upward to the left upper quadrant. The cecum is small and poorly outlined. May 20, 1958.
Fig. 5. Case II: Upright view. Multiple hoopshaped small bowel loops. An air-fluid level is present in the cecum. May 20, 1958.

confirm the presence of cecal hypertrophy. Two cases have been operated upon, and this finding was demonstrated.

CASE II (Figs. 4–6): H. O., a 51-year-old white female, entered Cook County Hospital on May 20, 1958, with a two-week history of right and left upper quadrant pain and vomiting several hours after the ingestion of food.

*Physical Examination:* The patient was moderately obese, with a somewhat distended abdomen. There were no palpable masses, and active bowel sounds were present.

*Laboratory Findings:* Red blood cell count, 3,600,000; white count 6,250 with 67 per cent polymorphonuclears; urine, normal.

*Roentgen examination,* May 20, revealed multiple distended loops of small bowel. On the upright film a long fluid level was seen in the cecum. The large bowel was not demonstrated beyond the cecum. The diagnosis at this time was obstruction of the colon. On May 22 a barium enema study showed the obstructing lesion to be in the distal hepatic flexure. Another film study, May 23, revealed dilatation of the cecum and ascending colon, although the cecal diameter was only 6 cm. Remnants of barium were seen in the collapsed colon. On May 26 the patient vomited fecal-like material, and at that time the abdomen was markedly distended, with high-pitched obstructive bowel sounds present. A one-stage right hemicolectomy was performed.

Fig. 6. Case II: Barium enema study. An obstructing lesion is seen at the hepatic flexure. The cecum is dilated but not as much as the ascending colon. Impression: Carcinoma of the hepatic flexure with incompetence of ileocecal valve. May 23, 1958.

*Pathological examination* revealed a completely obstructing adenocarcinoma of the hepatic flexure. The colon proximal to the point of obstruction

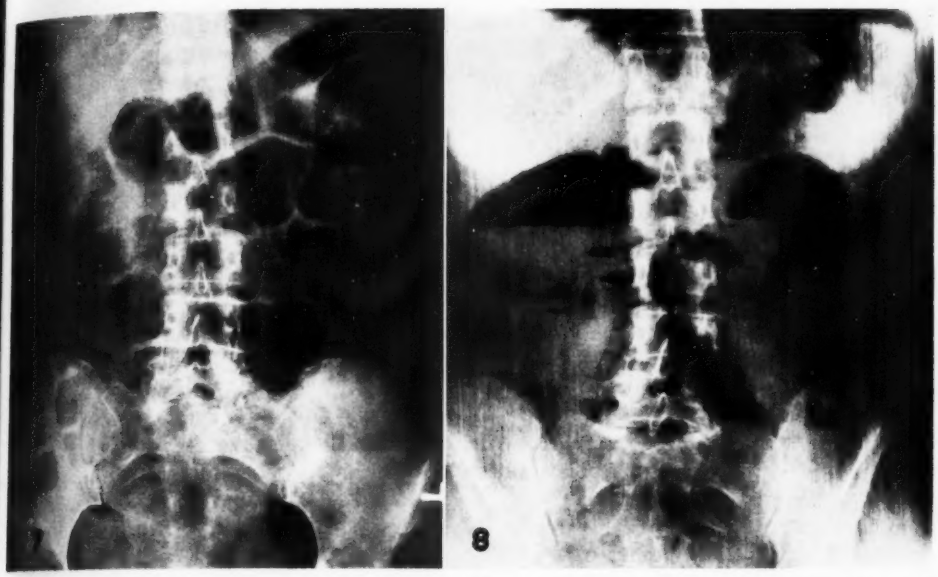

Fig. 7. Case III (Type II): Anterposterior view. Multiple loops of distended small bowel. Note small cecum with thickening of the haustral markings.

Fig. 8. Case III: Upright view. A long air-fluid level is seen in the right upper quadrant, probably in the ascending colon.

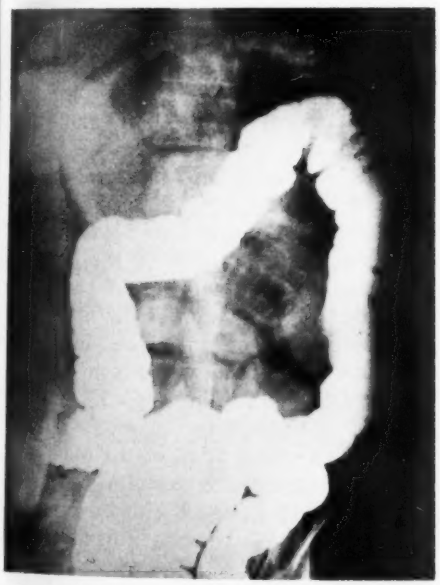

Fig. 9. Case III: Barium enema study revealing an obstructing lesion in the hepatic flexure. The cecum and ascending colon are dilated but not outstandingly so. Note barium filling of loops of small bowel and ascending colon.

showed gross evidence of hypertrophy of the walls, down to the level of the cecum.

CASE III (Figs. 7–9): R. F., a 53-year-old white female, initially entered the hospital on Sept. 15, 1958, with a history of abdominal pain and vomiting of eighteen months duration. She had been treated by her physician for ulcer, with little relief. There was a history of hematemesis and tarry stools on one occasion. The patient underwent an upper gastrointestinal examination and then signed herself out. She returned two days later with distention, vomiting, and obstipation.

*Laboratory Findings:* Red blood cell count, 3,200,000; white cell count, 10,100, with 63 per cent polymorphonuclears; hemoglobin 60 per cent; urine, normal.

*Roentgenography:* The original films, Sept. 15, were reviewed, and the anteroposterior view revealed small bowel distention and no air distal to the ascending colon. An upright film showed a definite air-fluid level in the cecum and multiple small levels in the small bowel. A barium enema study on Sept. 19 revealed an obstructing lesion of the hepatic flexure. Barium from the previous upper gastrointestinal examination was present in the small intestine and in the cecum, which was not unusually enlarged.

*Surgery:* On Sept. 19, a one-stage right hemicolectomy was done. An obstructing adenocarcinoma of the hepatic flexure was found. The entire colon proximal to the lesion was hypertrophied.

In both these cases the original film

studies revealed predominantly small bowel distention, and it can be surmised that the valve was incompetent and that the cecum had an opportunity to hypertrophy, which was proved by surgery.

## DISCUSSION

In all, 25 cases of large bowel obstruction were reviewed, and an attempt was made to separate them into three basic groups: Type IA, closed-loop obstruction; Type IB, closed-loop obstruction with a superimposed small bowel obstruction as a result of the large fluid-filled cecum and tightly closed ileocecal valve; Type II, incompetence of the ileocecal valve with resultant hypertrophy of the colon and a high degree of small-bowel distention.

The obstructions were the result of carcinoma, an extrinsic mass compressing the colon (appendiceal abscess), fecal impaction, and diverticulitis. Other reported series usually parallel this group (15). Volvulus was not included in the study.

Estimates on the percentage of cases of carcinoma which obstruct the large bowel vary from 9.54 per cent at the University of Minnesota to 35.6 per cent in England (16). In large municipal hospitals the percentages are higher, as neglected cases are more frequent.

Of our 25 cases, 8 were associated with incompetence of the ileocecal valve. In the other 17 cases the valve was competent; 2 were of Type IA and 15 of Type IB. Thus, in a relatively small series, roughly 37 per cent of the cases were probably the result of incompetence or relative incompetence of the valve. The data seem to indicate that the more distended colons are found in those cases where thinness of the cecal wall points to a competent ileocecal valve, with or without secondary obstruction to the small bowel by the distended cecum and tight ileocecal valve.

The occurrence of smaller, less distended colons, with thicker hypertrophied walls, can best be explained by a mechanism which gives the colon sufficient time to accommodate itself to the obstruction by releasing its contents through the ileccecal valve into the small bowel.

## DIFFERENTIAL DIAGNOSIS

From the standpoint of differential diagnosis the greatest difficulty is encountered in those cases of large bowel obstruction with accompanying small bowel distention. Following are some of the more important conditions to be considered:

In *generalized paralytic ileus* both the small intestine and colon are the seat of a more or less pronounced meteorism (3) and fluid levels are noted in both segments of the gut. The fluid levels are seen at about the same height in individual loops, and no "step-ladder" effect is observed. The dilatation of the bowel usually extends to the distal rectum.

*Mesenteric thrombosis* may resemble a large bowel obstruction with dilatation of both the small and large bowel. According to Frimann-Dahl (3), the fluid levels in the colon are not distinctly marked. It is suggested that a barium-enema study be done in all cases of bowel obstruction to rule out this possibility. The history may be of great assistance in such cases.

*Incomplete small bowel obstruction* usually demonstrates the more classical findings of dilated small bowel, "step-laddered" in character, with activity of the bowel as evidenced by different air-fluid levels in the same loop on an upright film. The colon is normal or diminished in caliber. A barium enema study shows no evidence of obstruction in the large bowel.

*Acute fulminating ulcerative colitis* demonstrates distention of the colon with multiple irregular nodules scattered throughout (20). A barium enema discloses the true character of the condition.

## SUMMARY

In *incompetence*, or relative incompetence, of the ileocecal valve with large bowel obstruction, we can expect to find hypertrophy of the colon with multiple distended loops of small bowel due to

reflux. This type of obstruction is less likely to result in perforation at the cecum, and can be handled by transverse colostomy.

With a *competent* valve, the picture is one of a large dilated colon with a large thin-walled cecum. If this progresses, small bowel distention occurs, probably due to secondary obstruction as a result of the fluid-filled cecum and a tightly closed ileocecal valve, with eventual perforation, if immediate surgery is not performed. Cecostomy should be done to inspect the cecum directly and to relieve the pressure upon it.

NOTE: Acknowledgment is made to Dr. Irvin F. Hummon for editorial assistance in preparing this paper and to Dr. Saad Beltagui of Alexandria, Egypt, a former resident in Radiology at the Cook County Hospital, who assisted in obtaining the case material.

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## SUMMARIO IN INTERLINGUA

### Le Rolo del Valvula Ileocecal in Obstruction del Intestino Crasse: Reporto Preliminar

Es presentate un revista de vinticinque casos de obstruction del intestino crasse. Es distinguite tres gruppos fundamental: Typo IA, obstruction a ansa claudite, in que un competente valvula ileocecal permitte le continue entrata del contento del intestino tenue a in le intestino crasse e preveni su reflexo; typo IB, obstruction a ansa claudite con superimposition de obstruction de intestino tenue como resultato del replenation del allargate ceco de liquido e del firme clausion del valvula ileocecal; e type II, un incompetente valvula ileocecal con consequente hypertrophia del colon e un alte grado de distension del intestino tenue. Circa 37 pro cento del hic revistate micre serie de casos essseva probabilemente le resultato de incompetentia o de relative incompetentia del valvula ileocecal.

Le datos pare indicar que le colones plus distense es trovate in le casos in que tenuitate del pariete cecal signala un competente valvula ileocecal con o sin obstruction secundari in le intestino tenue. Le occurrentia de minus distense colones con plus spisse parietes hypertrophic se explica le melio per un mechanismo que provide le tempore requirite per le colon pro accomodar se al obstruction per discargar su contento via le valvula ileocecal a in le intestino tenue.


SUMMARIO IN INTERLINGUA

**Fibrosis Retroperitonee: Un Revista Anatomic e Radiologic, con Un Reporto de Quatro Nove Casos e Un Explication del Pathogenese**

(*Pagina 380*)

Quatro casos de benigne idiopathic fibrosis retroperitonee, originalmente cognoscite como fibrosis periureteral, es presentate, altiante le total del casos in le litteratura a 43. Un placa fibrotic inveloppa un o ambe ureteres e le grande vasos del abdomine. Histologicamente le condition es identic con lipogranuloma sclerotisante. In su phase precoce, illo resimila multo le morbo de Weber-Christian o panniculitis non-suppurative. Clinicamente, perdita de peso e dolores del flancos es symptomas quasi universal. Usualmente le morbo progrede a un forma bilateral.

Le imagine radiologic es characteristic sed non specific. Le aspectos le plus prominente es demonstrabile per pyelographia retrograde. Hydronephrosis es evidente. Le ureter proximal es dilatate e tortuose e alora se torna in direction medial per un angulation abrupte. Le ureter se restringe gradualmente usque a un fixe segmento stenotic que ha un longor de 3 a 6 cm e se trova usualmente opposite al corpores del quarte e quinte vertebra lumbar. Postea le calibre normal del ureter es gradualmente restablite.

Le etiologia specific non es cognoscite, ben que varie suggestiones ha essite facite.

Le tractamento de election es le intervention chirurgic. Le ureter es distachate ab le placa fibrotic e transplantate, con o sin nephrostomia e con o sin resection ureteral. Le prognose es excellente, providite que le function renal non es compromittite. Nulle recurrentias ha essite reportate.

# Coarctation of the Aorta

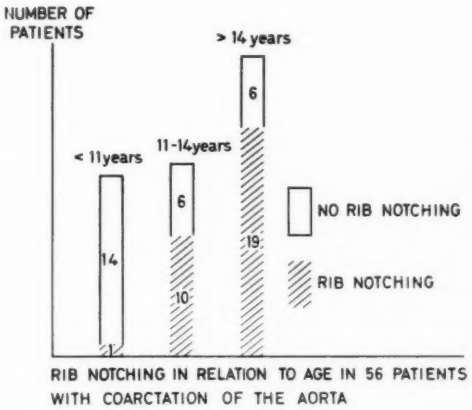
## Relation Between Roentgenologic and Hemodynamic Findings[1]

C. E. GUDBJERG, M.D., and OLAF PETERSEN, M.D.

DURING RECENT years several cases of atypical coarctation of the aorta have been reported, including what Steinberg (1956) calls pseudocoarctation, an isthmic stenosis without abnormal hemodynamic consequences. It has been pointed out by Stevens (1958), however, that in such cases one can hardly speak of a true coarctation, but rather of a buckling of the aorta due to an unusually short ligamentum arteriosum. He did not find actual stenosis of the lumen, although radiologically this might be suggested by the kinking of the aorta.

From Sweden, Karnell (1959) has published a large series of cases of coarctation of the aorta studied by preoperative as well as postoperative aortography. Especially has he examined the intra-arterial pressure before and after operation and found that for all age groups the systolic tension proximal to the coarctation was raised, on an average, whereas the diastolic pressure was not significantly abnormal. Direct examination of the intra-arterial pressure revealed a pulse amplitude which proximal to the stenosis was three times that measured distally. The median pressure averaged 30 mm. Hg higher in the upper limbs than in the lower.

Prompted by these American and Swedish investigations, we studied our series with a special view to the influence of the stenosis upon hemodynamic conditions. We were interested particularly in the relation between the width of the aorta proximal and distal to the stenosis, on the one hand, and in the intra-arterial pressure as well as the pressure gradient between the upper and lower limbs, on the other. Since the results of our studies are not entirely in keeping with previous findings, they will be reported here.




RIB NOTCHING IN RELATION TO AGE IN 56 PATIENTS WITH COARCTATION OF THE AORTA

Diagram 1

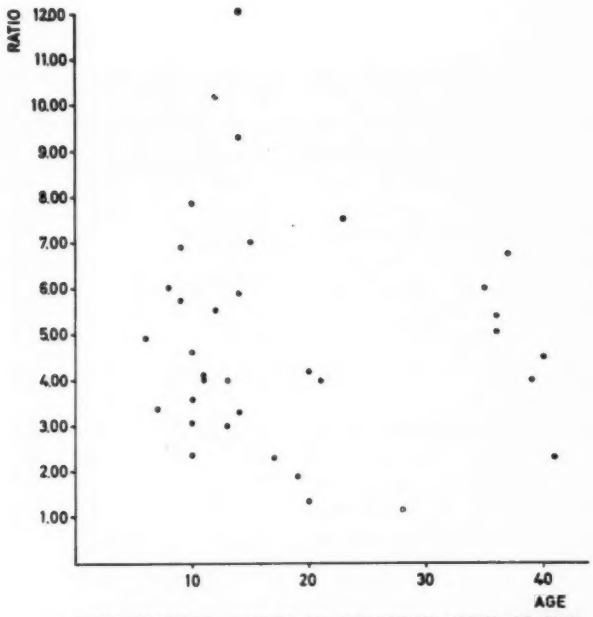
The series includes 56 patients with coarctation. Sex ratio and age distribution were as follows:

| | |
|---|---|
| *Less than 11 years* | |
| Males | 11 |
| Females | 5 |
| Total | 16 |
| *11 to 14 years* | |
| Males | 8 |
| Females | 7 |
| Total | 15 |
| *Over 14 years* | |
| Males | 17 |
| Females | 8 |
| Total | 25 |
| *Total (all ages)* | |
| Males | 36 |
| Females | 20 |
| Total | 56 |

As is usual, males predominate, but the male preponderance is somewhat less marked (a ratio of 1.8:1) than in most other series, in which it has been found to be about 2.5:1 to 3.0:1 (Brodén and Karnell, 1958; Holzmann, 1952).

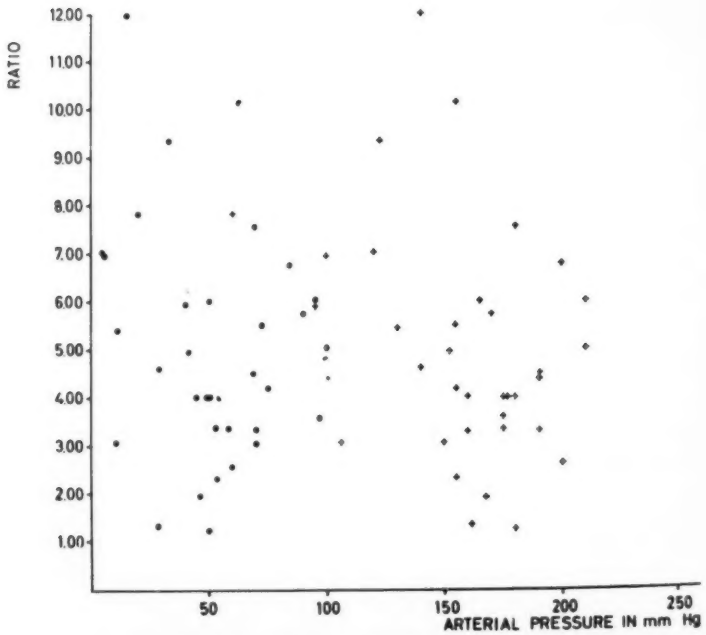
Diagram 1 gives a survey of the frequency of rib notching in relation to age. In our series, notching did not occur with

[1] From the Radiological Department (Director: Professor Gregers Thomsen, M.D.), Rigshospitalet, Copenhagen, Denmark. Accepted for publication in January 1960.




RATIO OF CROSS SECTION OF ASCENDING AORTA TO THAT OF THE DESCENDING PORTION IN RELATION TO AGE IN 35 PATIENTS WITH COARCTATION OF THE AORTA

Diagram 2




RATIO OF CROSS SECTION OF ASCENDING AORTA TO THAT OF THE DESCENDING PORTION IN RELATION TO ♦ = SYSTOLIC PRESSURE
● = SYSTOLIC GRADIENT

Diagram 3

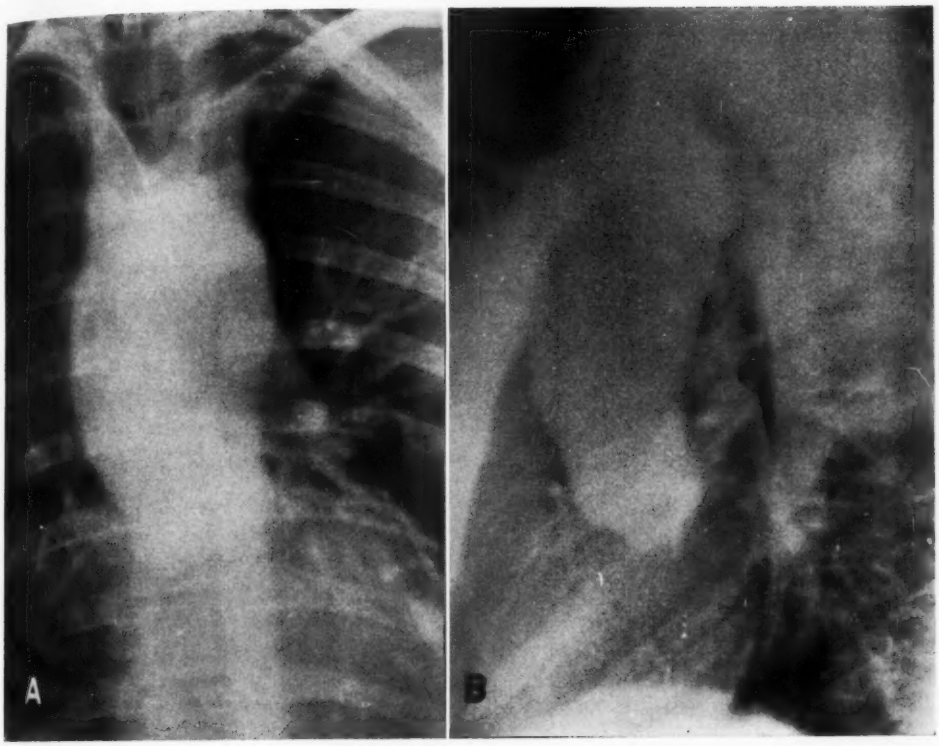



Fig. 1. Fifteen-year-old girl. Ratio between width of the ascending and the descending aorta 7.02. Normal intra-arterial pressure. No collaterals. A. Frontal view. B. Lateral view.

great frequency until the age of eleven to fourteen years. This is not quite in agreement with previous findings (Figley, 1954; Kjellberg *et al.*, 1955).

Measurement of the intra-arterial pressure in the upper and lower limbs was done in 35 cases. These cases were studied in particular detail with respect to hemodynamic function and aortic dimensions. Measurements were made, in the lateral and anteroposterior projection, of the diameter of the ascending aorta at the site of its greatest width and of the descending aorta at the level of the diaphragm. From these figures the corresponding area of the cross section was calculated. The relation between these cross-section areas has been shown in aortograms and angiocardiograms of persons in whom no disease could be found to be normally about 4.00. In Diagrams 2 and 3 this ratio is plotted along the ordinate. Unlike Brodén and

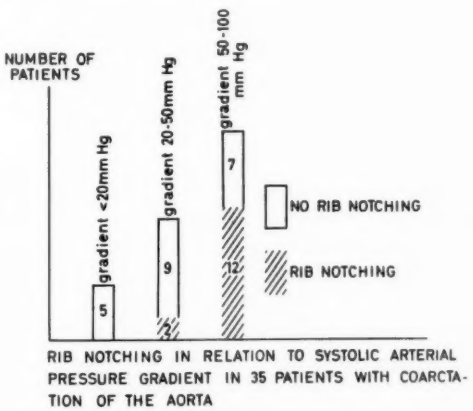



Diagram 5

Karnell, we did not find a correlation between advancing age and increasing width (Diagram 2). Diagram 3 shows the width of the ascending and descending portions in relation to the systolic pressure in the brachial artery, marked by crosses, and

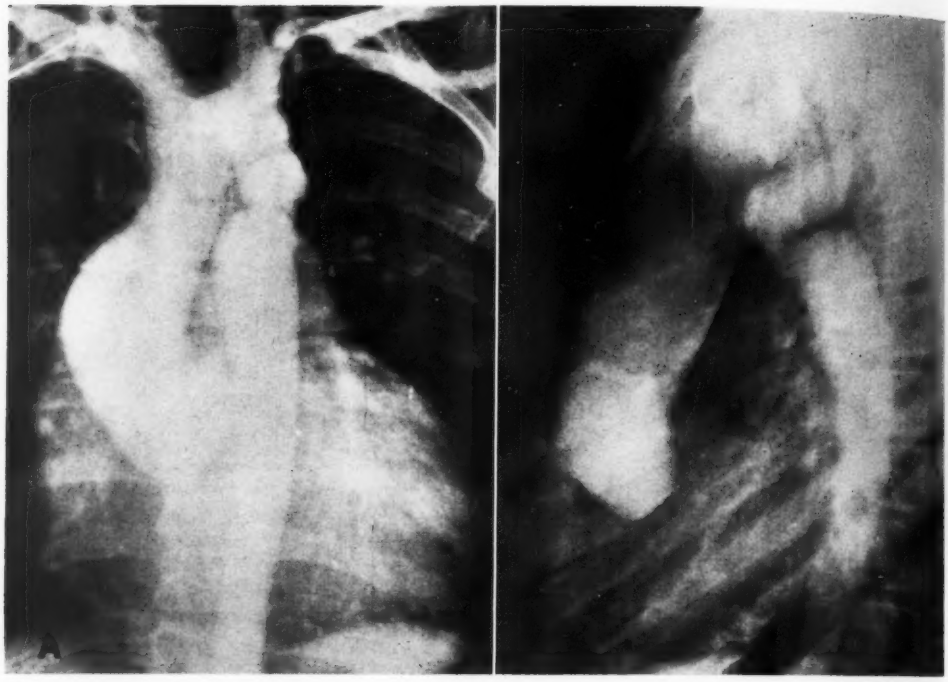


Fig. 2. Ten-year-old girl. Ratio between width of the ascending and the descending aorta 7.84. Low intra-arterial pressure. No collaterals. A. Frontal view. B. Lateral view.

in relation to the systolic pressure gradient between the brachial and femoral arteries, marked by dots. Here, also, there is no demonstrable correlation between increasing pressure and great width, the ratio being just as often low at a high pressure and a high gradient as high at a low pressure and low gradient.

Diagram 4 shows the relation between rib notching and the systolic arterial pressure gradient. In this respect, there is a closer correlation between the radiographic findings and the hemodynamic conditions, the number of notchings increasing with increasing pressure gradient.

When grouped according to dilatation or nondilatation of the ascending aorta, the material shows unmistakable dilatation in 20 patients and no dilatation in 15. In the group without dilatation of the ascending aorta, comprising 15 patients, a high arterial pressure was found in 14. Only one had a normal intra-arterial pressure, no collaterals, and no notching. In the group with dilatation, 16 had a high arterial pressure in the brachial artery, while 4 had a normal arterial pressure, no collaterals, and no rib notching.

These 4 cases are in fact the most interesting ones, as they represent what Steinberg (1956) has called pseudocoarctation:

CASE I (Fig. 1): A girl 15 years of age with an arterial pressure in the brachial artery of 120 systolic and 100 diastolic, and in the femoral artery 115 systolic and 100 diastolic. In other words, there was no abnormal pressure gradient.

CASE II (Fig. 2): A 10-year-old girl who shows typical coarctation and dilatation of the ascending aorta. The intra-arterial pressure measured at operation above and below the stenosis was 60 systolic, 40 diastolic.

CASE III (Fig. 3): A boy aged 9, with an arterial pressure in the brachial artery of 98 systolic and 70 diastolic, and in the femoral artery of 92 systolic and 70 diastolic. The pronounced dilatation of the ascending aorta can, therefore, hardly be due to the stenosis.

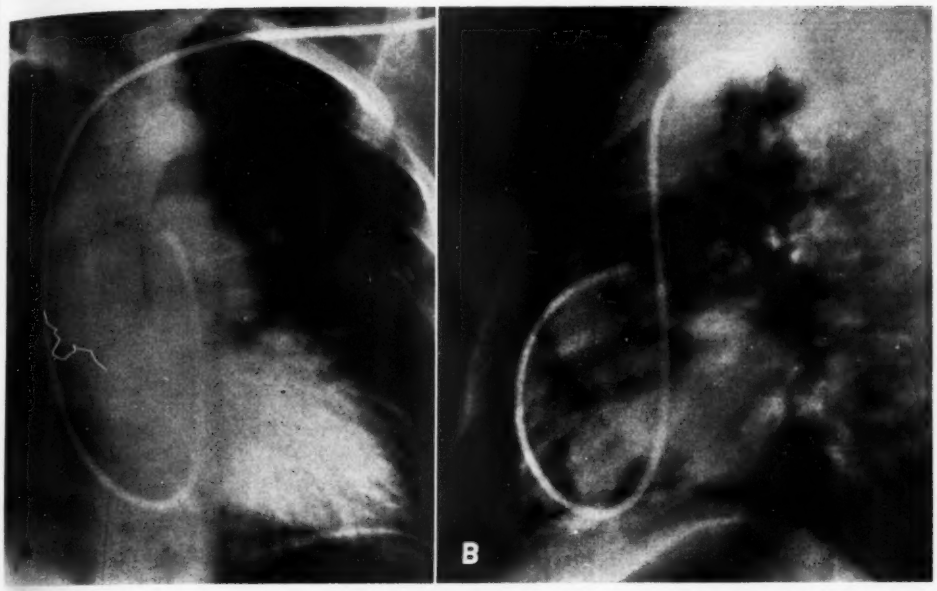



Fig. 3. Nine-year-old boy. Ratio between width of the ascending and the descending aorta 6.92. Normal intra-arterial pressure. No collaterals. A. Frontal view. B. Lateral view.

CASE IV (Fig. 4): A man, aged 36, with a history of precordial pressure for about one month before admission. Objective examination revealed a murmur over the aorta, systolic as well as diastolic. Chest radiography showed an increase in aortic width; aneurysm was suspected, and thoracic aortography was performed. This showed a Valsalva aneurysm as well as pronounced typical coarctation. There was no collateral circulation, and satisfactory filling was soon obtained distal to the site of narrowing. The intra-arterial pressure above the coarctation was 132/80, and in the femoral artery 120/80. There was thus no hemodynamic action worth mentioning. This last patient represents a case of Valsalva aneurysm combined with asymptomatic coarctation.

## COMMENT

From our studies, it must be concluded that, in addition to classical coarctation of the aorta with characteristic radiographic appearances, a high intra-arterial pressure in the upper limbs and a low intra-arterial pressure distal to the area of narrowing, development of collaterals, and consequent rib notching, there is another type in which hemodynamic findings are normal. This type is characterized by pronounced dilatation of the ascending aorta, a dilatation which can hardly be ascribed to the stenosis. Though its cause is still obscure, very probably it is of an entirely different pathogenesis, presumably a systemic disease of the vascular wall.

## SUMMARY

In a series of 56 cases of coarctation of the aorta, direct measurements of the intra-arterial pressure proximal and distal to the stenosis were obtained in 35 patients.

These measurements were compared with the width of the ascending and the descending aorta. No correlation between a high pressure above the stenosis and dilatation of the ascending aorta could be demonstrated.

In 4 of 20 patients with pronounced dilatation of the ascending aorta the intra-arterial pressure proximal to the site of coarctation was normal and no collaterals or notching of the ribs could be demonstrated.

In these 4 cases, 1 of which was combined with a Valsalva aneurysm, the coarctation had no hemodynamic consequences, and they are believed to represent what

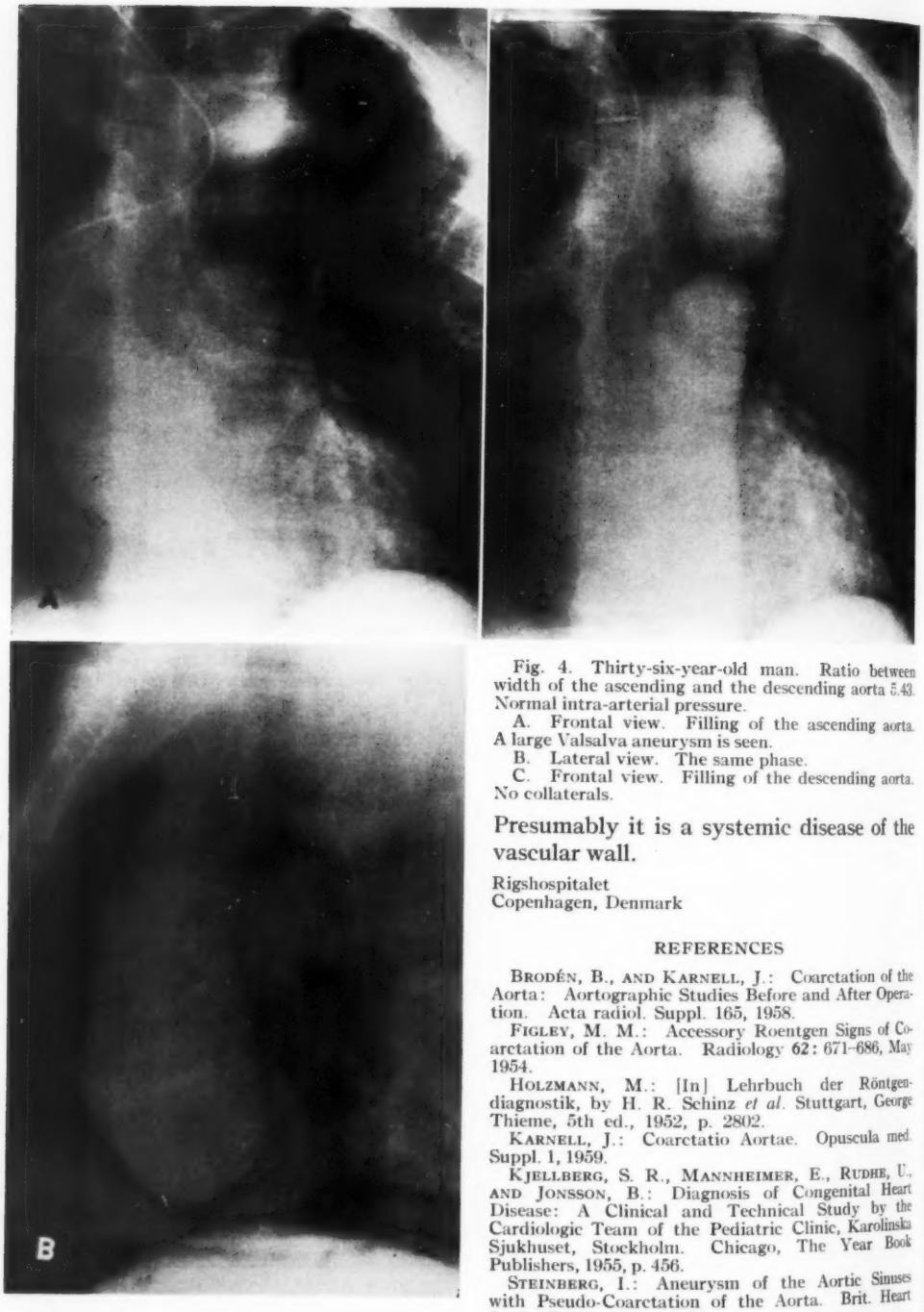


Fig. 4. Thirty-six-year-old man. Ratio between width of the ascending and the descending aorta 5.43. Normal intra-arterial pressure.

A. Frontal view. Filling of the ascending aorta. A large Valsalva aneurysm is seen.

B. Lateral view. The same phase.

C. Frontal view. Filling of the descending aorta. No collaterals.

Steinberg calls pseudocoarctation. The pathogenesis of this condition is obscure. Presumably it is a systemic disease of the vascular wall.

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SUMMARIO IN INTERLINGUA

## Coarctation del Aorta

In un serie de 56 casos de coarctation del aorta, mesurationes directe del tension intra-arterial proximal e distal al sito del stenose esseva obtenite 35 vices. Iste mesurationes esseva comparate con le largor del aorta ascendente e descendente. Nulle correlation inter alte tensiones supra le sito del stenose e le grado del dilatation del aorta ascendente poteva esser demonstrate.

In 4 inter 20 patientes con pronunciate grados de dilatation del aorta ascendente, le tension intra-arterial proximal al sito del coarctation esseva normal, e nulle collaterales e nulle indentation costal poteva esser demonstrate. In iste 4 casos—incluse 1 in que le condition esseva combinate con un aneurysma de Valsalva—le coarctation habeva nulle consequentias hemodynamic, e il pare tractar se hic de casos representante lo que Steinberg designa como "pseudo-coarctation." Le pathogenese de iste condition es obscur. Illo es presumitemente un morbo systemic del pariete vascular.

# Quantitative and Qualitative Evaluation of Skin Erythema

## I. Technic of Measurement and Description of the Reaction[1]

FLORENCE C. H. CHU, M.D., JOHN T. CONRAD, B.S.,[2] HARRY N. BANE, B.S.,[3] ARVIN S. GLICKSMAN, M.D. and JAMES J. NICKSON, M.D.

IT IS USUALLY agreed that the visual measurement of x-ray skin reaction is hampered by many psychological and physical difficulties that render quantitative description precarious if not impossible. Three main categories of difficulties can be described:

1. Variation in the chromatic acuity of the observers.
2. Variations in the ambient light in the examining suite, which influence the judgment of the observers.
3. Lack of quantitative means to evaluate the intensity of response.

To keep these factors at a minimum, it seemed desirable to develop an objective method for studying the skin changes produced by ionizing radiation.

In an effort to eliminate such variables as visual acuity and quality of the incident light, Sheard and his co-workers (1–3) developed a spectrophotometric method for analyzing skin color in normal and pathologic states. Edwards and Duntley (4) refined these technics and made an extensive study of the types and distribution of pigments in normal skin, showing that oxyhemoglobin, reduced hemoglobin, and melanin are the primary factors in determining skin color. Estimation of the amount of oxyhemoglobin and reduced hemoglobin may be made by reflectance measurements at 574 and 556 millimicrons, respectively. Since these two compounds contribute very little to the intensity of reflected light at the long wave lengths, the melanin content may be determined by measurement of the intensity of the reflectance spectrum between 660 and 680 millimicrons (Fig. 1). The absorption spectrum of normal skin is essentially the sum of these curves.

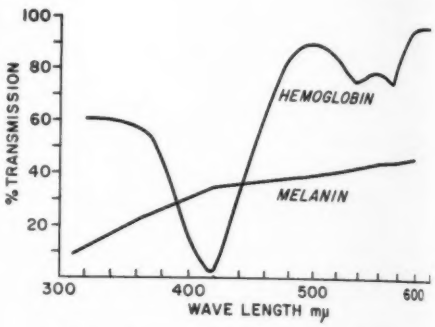


Fig. 1. Absorption spectra of normal skin.

In 1932 Harris and co-workers (5) employed the reflectance spectrophotometer for the study of x-ray-induced skin erythema. Their results were expressed in terms of relative luminosity, hue, and saturation. They measured only the irradiated areas, however, and did not compensate for normal variations of skin color due to changes in peripheral blood flow or variations in skin pigmentation. Their data, therefore, may be considered as a measurement of both the x-ray reaction and normal variations.

Jansen (6) in his investigations of ultraviolet erythema and pigmentation was able to eliminate the normal variations due to alterations in peripheral blood flow, width of the vessels, and seasonal changes, by the rather simple method of expressing data in terms of the per cent of normal

[1] From the Departments of Radiation Therapy and Medicine, Memorial Center for Cancer and Allied Diseases, New York, N. Y., and the Section of Radiobiology of the Division of Biophysics, The Sloan-Kettering Institute, New York, N. Y. This work was supported in part by the United States Public Health Service, Grant No. C-2443. Presented in part at the Eighth International Congress of Radiology, Mexico, D. F., Mexico, July 1956. Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

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[3] Kress Fellow in Radiobiology. Present address: National Jewish Hospital, Denver, Colo.

skin color. This was accomplished by taking readings of the adjacent normal skin on both sides of the irradiated area and obtaining a ratio of irradiated skin to nonirradiated skin × 100 for each important absorption band. A modification of Jansen's technic has been used for quantitative determination of the x-ray-induced skin reaction.

## MATERIALS AND METHODS

For this study the Photovolt Model 610 Reflectance Meter, a filter spectrophotometer, was used for a quantitative determination of the x-ray skin reaction. The meter consists of two parts: the instrument proper, which contains a built-in galvanometer, a power supply and controls, and the "search unit," which comprises the light source and the recording photocell. The assembled unit is shown in Figure 2. Light from a 6-volt automobile headlight lamp with a concentrated filament is collimated by a double condensing lens, passes through the filter and through the opening of the annular photoelectric cell, and strikes the test surface. The diffusely reflected light registers on the photoelectric cell, but the specularly reflected light returns through the aperture of the photocell unit. Therefore, the shininess of the surface does not affect the readings. An external galvanometer whose sensitivity is approximately four times higher than that of the built-in meter was used for greater accuracy and ease of viewing.

Two types of optical filters were used. The majority of the preliminary work was done with Wratten gelatin filters. A total of seven filters was employed in order to obtain a rough reflectance spectrum of the skin. It soon became evident, however, that better isolation of certain segments of the spectrum was needed for an analytical expression of erythema. Increased resolution was provided by interference filters of the Fabry-Perot type.[4] The light transmission of these filters is about 45 to 50 per cent of the incident beam. The width is 12 to 14 millimicrons at half maximum and 30 to 35 milli-

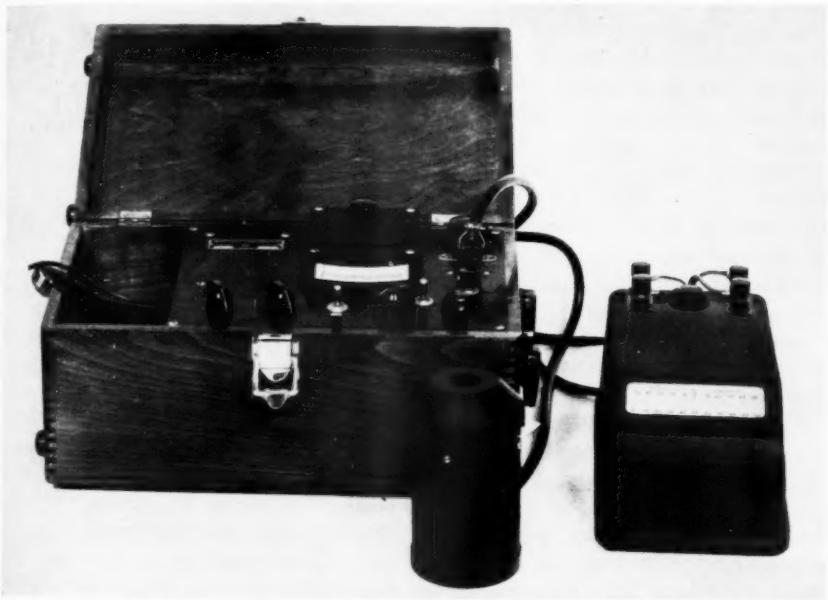

Fig. 2. Photovolt reflectance meter, model 610 (at left); search head with interference filter inserted (center); external galvanometer (right).

[4] Manufactured by Geraetebau-Anstalt Blazers and distributed in U. S. by Photovolt Co., New York.

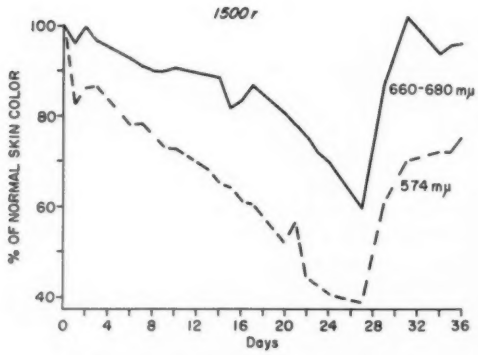


Fig. 3. Reflectance curves of the skin.

microns at one-tenth maximum. Calibration in this laboratory showed that the filters fell well within the manufacturer's specifications, except that the 576 millimicron filter actually has its peak at 574 millimicrons, a point that is still within the rather broad band of oxyhemoglobin. Melanin content was measured by a 660 to 680-millimicron Wratten filter.

Test doses of radiation were given to the medial surface of the arms or thighs of patients with disseminated cancer who were receiving radiation therapy to other areas. This area was selected for convenience of measurement and because it was less apt to receive ultraviolet irradiation during the period of observation. A general area was marked out and mapped with the photometer for uniformity of color at the three wave lengths. This matching process could be carried out to within 1 per cent for each filter. The test dose of radiation was given within this area, and each patient was followed with daily readings of the color changes.

The physical factors of irradiation were a 3-cm. cone; 100 kevp; 1.5 mm. Al h.v.l.; 15 cm. T.S.D. Most areas received a single dose of 1,500 r in air. The calculated skin dose was 1,500 rads. This was sufficient to cause a brisk reaction with subsequent dry exfoliation.

## RESULTS IN 20 SELECTED PATIENTS

The reflectance curves of the skin obtained from the test areas are presented in Figure 3. The curve at 574 millimicrons had a very characteristic shape. There were three separate phases: (*a*) an initial depression, which appeared within 24 hours of irradiation and lasted several days; (*b*) an intermediate period of varying length during which the depression was slight and variable; (*c*) a second, large depression during which the greatest reaction occurred. It was during this phase that the acute symptoms and signs of skin reaction appeared. These symptoms included a warm sensation, itching, and slight pain. The signs consisted of redness (Fig. 4) and sometimes swelling. This was followed by dry peeling of the skin (Fig. 5).

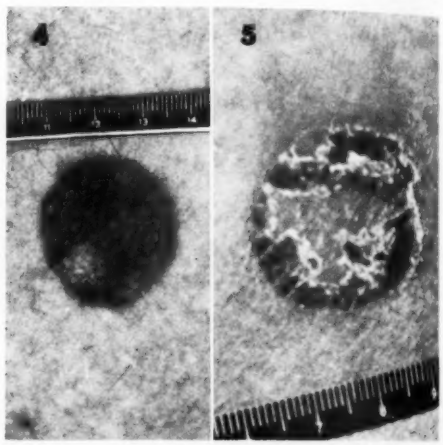


Fig. 4. Acute skin erythema.
Fig. 5. Dry peeling of the skin.

With smaller doses of radiation (Fig. 6) the intermediate section of the curve was slightly longer and the main reaction less severe in nature. The effect of these smaller doses on the first depression was variable, although the depression tended to increase with increasing x-ray dose. The time of onset and the depth of the second depression give the best correlation with dose.

The effect of a higher dose is also shown in Figure 6. These data were obtained from a patient who accidentally received radiation of an unknown amount tangential to the test area. The first depression was large, and the intermediate

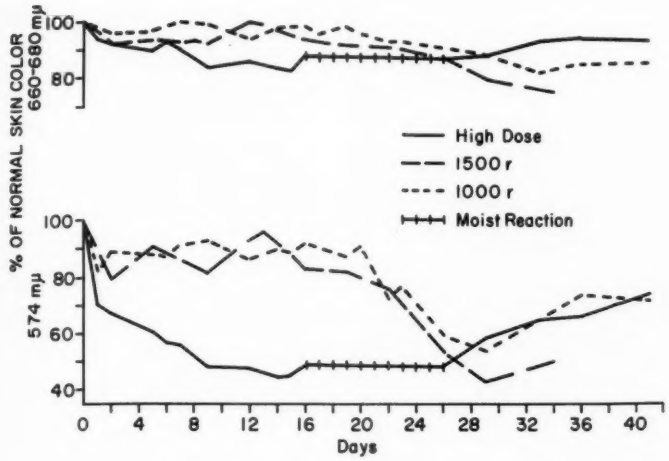


Fig. 6. Reflectance curves of the skin for different dose levels.

period merged into the second depression. The final result was a moist reaction of moderate severity. When a moist reaction occurs, the reflectance of the skin can be misleading. The curve actually rises slightly, indicating less reaction.

The 660 to 680-millimicron curve usually showed only a very slight initial depression (Figs. 3 and 6). A marked depression occurred almost simultaneously with the second depression of the 574-millimicron curve.

## DISCUSSION

The technic of spectrophotometry appears to be ideal for the quantitative measurement of color changes due to x-irradiation. The method is characterized by ease of utilization and validity of results. There are, however, certain faults in the procedure. One of these is that the absorption bands of blood are obscured by increases in melanin pigmentation, a situation which makes it difficult to separate the pigmentation from the increased blood flow. An attempt was made in these experiments to distinguish these two effects by utilizing the 660 to 680-millimicron Wratten filter to describe the pigmentation due to melanin and the 574-millimicron interference filter to characterize the changes in blood flow. The theory behind this action was the demonstration that melanin absorbed strongly throughout the visible spectra, whereas blood absorbs little light at the longer (red) wave lengths. Thus, if the blood flow increases but melanin content of the skin does not, the 574-millimicron curve should show a dip, whereas the 660 to 680-millimicron curve should remain relatively constant. With the two-filter method, it was possible to show, at least during the early stages of the erythema, such a dip at the 574 band but none in the 660 to 680-millimicron band. This would seem to indicate that separate resolution of these components is possible, at least during the second depression, both erythema and pigmentation appearing to take place simultaneously.

Although the results of these experiments coincide closely with the observations of some authors (6), they are at variance with those of others (7–9). The main area of departure appears to be in the intermediate period. Miescher (10), in his series of graphs, shows a second peak of red about this time, whereas in the observations reported here there is actually a lack of any great color change at this point in most cases. The length of this period, however, appears to be dose-dependent. It may be that with different

doses of irradiation, a second wave of erythema could be demonstrated in this intermediate period. This report deals almost entirely with the results obtained after 1,500 rads.

It must be pointed out that the length of observation periods is also an important factor in these studies and that, if the observations are halted in mid-experiment, it is possible to miss the main reaction entirely. Since the duration of the intermediate period is quite long, the experimenter may feel that the reaction is completed, whereas in actuality it has not yet begun. Many workers have arbitrarily chosen a certain day as the day for the main reaction and have made observations just at that time. Since the variability of individual sensitivity enters into the skin phenomenon, it is quite possible that a strong reaction could be overlooked with such a program.

Another important point is that the first depression is extremely labile in appearance. It is felt that this reaction was missed quite often in this series because of its early appearance. By the time the first observations were made, about twenty-four hours post-irradiation, the first depression was already disappearing, and its true depth could not be appreciated. This phenomenon has been reported previously (8).

## SUMMARY

A reflectance spectrophotometric method is described for measurement of the erythema and pigmentation in x-ray-induced changes. Results of the application of this method to human skin are reported. The reaction is characterized by three phases: (*a*) an erythema occurring within the first twenty-four hours, (*b*) a stable second period of slight increase in light absorption in the oxyhemoglobin and melanin bands, (*c*) a late reaction with a marked increase in pigmentation and possibly vascularity. The difficulty in distinguishing changes in hemoglobin absorption because of the overlap in melanin absorption has been pointed out.

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# Quantitative and Qualitative Evaluation of Skin Erythema

## II. Clinical Study in Patients on a Standardized Irradiation Schedule[1]

ARVIN S. GLICKSMAN, M.D., FLORENCE C. H. CHU, M.D., HARRY N. BANE, B.S.,[2] and JAMES J. NICKSON, M.D.

WITH THE development of an accurate and rapid method of quantitative determination of x-ray-induced erythema and pigmentation by means of a reflectance spectrophotometer (1), it seemed reasonable that the response of skin of different persons to a standard amount of ionizing radiation might be found to be recognizably different provided a sufficiently large group were carefully followed. The initial definition of "threshold erythema dose" as that dose of irradiation which in 80 per cent of the persons so exposed produces a visible erythema in two to four weeks time implicitly recognizes an insensitive group of patients amounting to 20 per cent. An experimental system to measure the extent of subjective and objective response of patients to ionizing radiation was devised and is reported here.

### METHODS AND MATERIALS

Patients with carcinoma of the breast referred for routine postoperative radiation treatment participated in this study. A three-field technic provided irradiation of the supraclavicular nodes through anterior and posterior opposing fields, averaging 13 × 15 cm., and the internal mammary nodes through a single anterior field averaging 15 × 8 cm. (Fig. 1). Normally in three and a half weeks a dose of 3,500 rads was delivered to the supraclavicular region, with a similar dose and time relationship for the internal mammary area. The factors were 250 kevp, 2 mm. Cu h.v.l., and a T.S.D. of 70 cm. for the supraclavicular fields and 50 cm. for the internal mammary field. The internal mammary field was specifically chosen for observation because (*a*) the skin dose

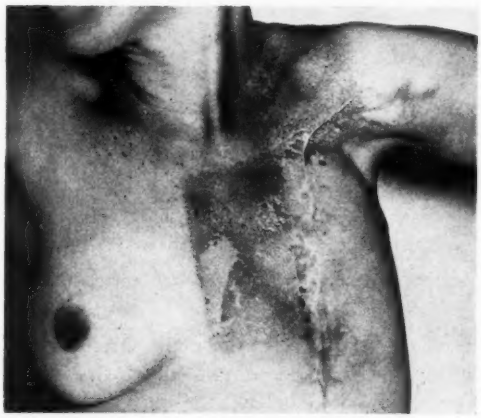

Fig. 1. Routine postoperative irradiation, carcinoma of the breast.

remained more or less constant, ranging from 4,200 to 4,700 rads for a depth dose of 3,500 rads at 4 cm.; (*b*) this area was easily observed; (*c*) the surface was relatively flat, so that the readings by physical instrumentation were technically easier.

Every effort was made to minimize variations of treatment conditions: these patients were treated by one technician, with a single x-ray unit, and under the direct supervision of one radiotherapist (F.C.H.C.).

The skin dose was measured by Baldwin Farmer air ionization chambers taped to the skin surface during each treatment. One member of the Physics Department was responsible for all phases of the physical dosimetry. The measured doses were compared with the calculated doses and corresponded very well. The average daily measured dose was 250 rads plus or minus 12 rads.

The patients were seen by three physicians—two radiotherapists and an in-

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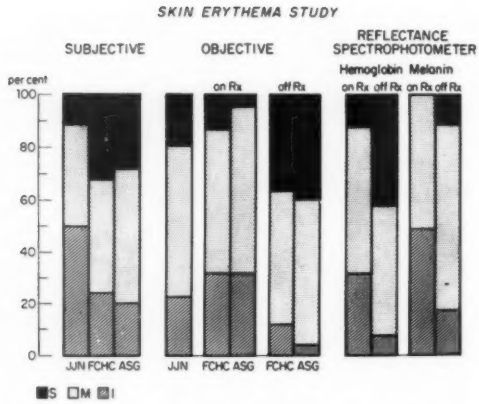


Fig. 2. Summary of results of skin erythema study.

ternist—at weekly intervals in a special clinic, during the period of treatment and for four to six weeks post-treatment. Each patient was scored individually by each physician as to erythema, edema, moistness, dry peeling, epithelization, and pigmentation. The patient was also queried as to pain, burning, stiffness, itching, coughing, difficulty in swallowing, nausea, vomiting, and anorexia. Each physician kept his own tally on each patient for each weekly visit. This evaluation program was completed in 85 cases. Fifty of the 85 patients were also studied by means of the reflectance spectrophotometer described in Part I (1) of this study. Thus, in each patient a standardized treatment schedule of x-irradiation for carcinoma of the breast was used. The calculated dose was checked by the physical measurement of the skin dose with Baldwin Farmer chambers. In each instance a clinical evaluation was made by three physicians independently, scoring the subjective response to the radiation, on the basis of patient's statements, and objectively on the physicians' observations. Finally, the reflectance spectrophotometer was used to measure the skin erythema and pigmentation quantitatively.

## RESULTS

The results of this study are summarized in Figure 2. The evaluation of subjective response to the standardized irradiation program was good; better indeed than was anticipated. The difference in evaluation of subjective response by the two radiotherapists was as great as the difference between the two radiotherapists and the internist. In terms of the objective response, one radiotherapist (J. J. N.) did not separate on-treatment and off-treatment evaluation but considered them together in his final score for each patient. The average of the on-treatment and off-treatment evaluation of the other two physicians was very close to this and corresponds well with the reflectance spectrophotometer reading for on- and off- treatment. When the marked difference in backgrounds of the evaluating physicians is considered, plus the fact that one of them is partially color blind, the fact that the figures on an average compare so well is phenomenal.

TABLE I: COMPARISONS OF EVALUATION

| EVALUATION OF RESPONSE | | |
|---|---|---|
| **3 Physicians** | | |
| | Subjective | Objective |
| All Agree | 20 % | 38 % |
| 2 Agree | 80 % | 62 % |
| None Agree | - | - |
| **Physicians and Meter** | | |
| | On Rx | Off Rx |
| All Agree | 10.4 | 4.2 |
| 2 Agree $\frac{}{c}$ Machine | 37.5 | 16.7 |
| 1 Agrees $\frac{}{c}$ Machine | 25.0 | 37.6 |
| None Agree $\frac{}{c}$ Machine | 27.1 | 41.5 |

A closer scrutiny of the data revealed the following (Table I): All three observers agreed in their evaluation of the subjective response in 20 per cent of the cases, while two agreed in 80 per cent. In no instance was there a complete disagreement as to the intensity of the response. The evalu-

TABLE II: DISTRIBUTION OF RESPONSE AS A FUNCTION OF AGE

CASE DISTRIBUTION ACCORDING TO AGE

| | No. Cases | Subjective | | | | | Objective | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | I | II | III | IV | V |
| 30-39 | 10 | 30 | 10 | 20 | 40 | - | 10 | 10 | 40 | 40 | - |
| 40-49 | 20 | 20 | 10 | 25 | 35 | 10 | - | 10 | 20 | 55 | 15 |
| 50-59 | 24 | 21 | 12.5 | 25 | 29 | 12.5 | - | 21 | 50 | 25 | 4 |
| 60-69 | 22 | 9 | 23 | 32 | 22.5 | 13.5 | - | 36 | 23 | 41 | - |
| 70-79 | 8 | 12.5 | 12.5 | 25 | 12.5 | 37.5 | - | 12.5 | 37.5 | 50 | - |

TABLE III: DISTRIBUTION OF RESPONSE AS A FUNCTION OF COMPLEXION

CASE DISTRIBUTION ACCORDING TO SKIN COMPLEXION

| | No. Cases | Subjective | | | | | Objective | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | I | II | III | IV | V |
| Fair | 19 | 26 | 16 | 21 | 21 | 16 | 5.5 | 26 | 37 | 31.5 | - |
| Average | 48 | 19 | 16.5 | 31 | 23 | 10.5 | - | 19 | 37.5 | 39.5 | 4 |
| Swarthy | 5 | - | - | 40 | 40 | 20 | - | - | 20 | 60 | 20 |
| Negro | 13 | 7.5 | 15.5 | 46 | 15.5 | 15.5 | - | 23 | 46 | 31 | - |

ation of the objective response showed 38 per cent full agreement; in 62 per cent two were in accord, and again there was no instance of total disagreement. When the evaluation of the physicians was scored against the reflectance spectrophotometer, however, the situation was somewhat different. All three failed to agree with the machine in 27 per cent of the on-treatment cases and in 41 per cent after completion of treatment. All agreed in only 10 per cent of the cases on-treatment and in 4 per cent of those off-treatment.

A numerical scale of 1 to 5, indicating increasing sensitivity was applied to each patient for each weekly score by the physician and by the reflectance spectrophotometer. The simple arithmetic average for the subjective response and objective response was assigned to each patient. From this was plotted the distribution of patient response on a scale of 1 to 5 for subjective and objective evaluation (Fig. 3). It can be seen that essentially a normal distribution pattern emerges.

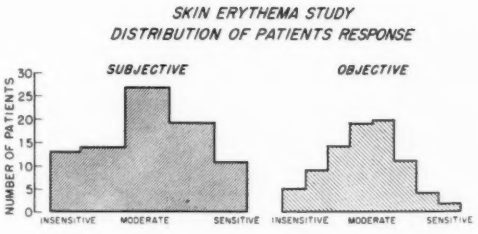


Fig. 3. Distribution of patient's response.

The data for this group of patients were further analyzed in terms of age and complexion. The average age was fifty-five, with a range from thirty-two to seventy-six. Age *per se* did not appear to be an important factor in terms of either subjective or objective response (Table II). Neither was the response affected by the complexion of a patient. In Table III. which shows the distribution of patients in terms of their subjective and objective response, there appears no statistical difference in response as a function of skin color. This holds true as one moves from fair-skinned patients to the Negro population.

## DISCUSSION

The data accumulated in this study indicate that, although the attending physicians agreed among themselves fairly well as to the intensity of both subjective and objective reactions, there was a lack of agreement with the reflectance spectrophotometer. A value judgment of many factors must be integrated by each physician arriving at his final score of objective response. On the other hand, the reflectance spectrophotometer measures the hemoglobin and melanin content (2, 3) only and for these values is superior even to the trained observer's eye. But, as reported in Part I of this study, a moist reaction actually causes a lower erythema reading. Edema and dry or moist desquamation do not influence the machine but do play a role for each physician as he arrives at a score for the patient.

It was also extremely interesting to

note that in the group of patients studied there was no statistical difference in distribution of the kinds of response in fair-skinned, average-complexioned, and Negro patients. Although it is generally accepted by the members of the radiotherapy profession (4, 5) that light-skinned patients tolerate irradiation less well than dark-skinned persons, and that pigmentation is increased in the dark-skinned population over the light-skinned, no evidence of correlation was found between intensity of skin reaction and color of skin.

Experienced radiotherapists will recall patients whose reaction to irradiation systemically or locally was so vigorous as to necessitate termination of treatment after only two-thirds or three-fourths of the usual time-dosage relationship accepted by most patients (6). In some, the response of the tumor appeared to correlate better with the severity of the biological response than with the physically measured amount of energy delivered to the patient.

It would appear from the foregoing that a biological *triage* of responsiveness to ionizing radiation, at least as far as the skin is concerned, does in fact exist. The correlation of these observed classes with other kinds of biological response, *i.e.*, degree of late fibrosis and, perhaps most important, tumor response, must await further studies of these and similarly identified patients. It seems probable that the vigor of reaction of tumor cells to irradiation will be found in the end to correlate more with biological factors than with physical factors.

SUMMARY

A study of skin erythema and pigmentation was made on 85 patients receiving standardized postoperative radiation therapy for carcinoma of the breast. While the three attending physicians who performed this study agreed among themselves fairly well as to the intensity of the reaction of the patients both subjectively and objectively, there was a lack of agreement between the physicians and the reflectance spectrophotometer. For hemoglobin and melanin content the meter was superior even to the trained observer's eye. Edema and dry or moist desquamation, however, did not influence the meter but did play a role in each physician's score for the patients.

In this group of patients a biological *triage* of responsiveness to ionizing radiation was found. Age, *per se*, did not seem to be an important factor in terms of either the objective or the subjective response. There was no statistical difference in the distribution of intensity of response as a function of skin color.

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SUMMARIO IN INTERLINGUA

**Evalutation Quanti- e Qualitative de Erythema del Pelle**

*I. Technica del Mesuration e Description del Reaction*

(*Pagina 406*)

Es describite un methodo spectrophotometric a reflectantia pro le mesuration del erythema e del pigmentation inducite per radios X. Resultatos del application de iste methodo al pelle human es reportate.

Le reaction es characterisate per tres phases—sequentemente (a) Un erythema que occurre durante le prime vinti-quatro horas; (b) un stabile secunde periodo in que il ha un leve augmento del absorption de lumine in le bandas de oxyhemoglobina e de melanina; e (c) un reaction tardive, con marcate augmentos del pigmentation e possibilemente con vascularitate. Es signalate le difficultate de distinguer le alterationes in le absorption de hemoglobina in consequentia del fusion partial con le absorption de melanina.

## SUMMARIO IN INTERLINGUA

### Evalutation Quanti- e Qualitative de Erythema del Pelle

*II. Studio Clinic de Patientes sub Tractamento Secundo Un Regime Standardisate de Irradiation*

(*Pagina 411*)

Un studio de erythema del pelle e de pigmentation esseva effectuate in 85 patientes sub tractamento secundo un standardisate regime de radio-therapia postoperatori pro cercinoma mammari. Le patientes esseva vidite a intervallos septimanal per tres medicos durante le periodo del tractamento e durante quatro a sex septimanas subsequente, con graduationes ascribite a illes individualmente pro lor erythema, le humectate edematose, le squamation sic, le epithelisation, e le pigmentation, e etiam super le base de symptomas subjective. Cinquanta patientes esseva etiam examinate per medio del spectrophotometro a reflectantia (vide p. 406).

Durante que le tres medicos se trovava satis ben de accordo in lor judicamento del intensitate del reactiones—tanto objective como etiam subjectivemente—il esseva notate un manco de accordo inter le medicos e le spectrophotometro reflectantial. Pro determinationes del contento de hemoglobina e de melanina, le instrumento esseva superior al inerme oculo de mesmo un experte observator. Edema e desquamation sic o humide non influentiava le spectrophotometro sed esseva de signification in le judicamentos del medicos.

In iste gruppo de patientes, un triage biologic del responsivitate a radiation ionisante esseva constatate. Le etate del patientes non pareva, per se, representar un factor importante, tanto con respecto al objective como etiam con respecto al subjective responsa, e similiemente nulle differentia statistic esseva constatate in le distribution del intensitate del responsa como function del color del pelle.

# Problems of Developing a Film Method for Regularly Checking Radiation Output of X-Ray Machines

LEONARD STANTON, M.S.

THE ROENTGEN output rate of an x-ray unit may vary considerably, even when control settings are carefully reproduced. This is because only an indirect relationship exists between such settings and the actual factors of x-ray production, as illustrated below:

*Kilovoltage:* Selector switches determine the voltage impressed on the high-tension transformer primary winding. The actual tube kilovoltage, however, may also be affected by the following: valve tube malfunction due to gas or poor filament contact, insulation breakdown, a change in length of shock-proof cables, etc. As shown below, the roentgen output varies greatly with kilovoltage; a 1 per cent change in kilovoltage produces as much as 3.5 per cent change in output (Fig. 11).

*Filtration:* As is well known, the inherent filtration of x-ray tubes increases gradually in use. This is due to target roughening, as well as the deposit of tungsten on tube structures traversed by the useful beam. Toward the end of tube life, both processes may be accelerated, with corresponding dramatic loss of x-ray intensity. The author has observed a 25 per cent decrease in output during a two-month period on one 200-kvp Villard unit and repeated 8 to 13 per cent reductions in several similar units during six-month intervals between calibrations.

*Miscellaneous:* While the following effects are less common, they have been reported from time to time, and several have been observed by the writer: misalignment and/or rotation of the x-ray tube in its housing; damage of target button at the focal spot, resulting in beam intensity reduction of about two-thirds; unauthorized resetting of kilovolt and milliampere meter zero settings after calibration, so that improper factors were used; reversal of one transformer connection on a Villard unit, resulting in operation at 100 kv constant potential instead of 200 kvp; etc.

Normally, the reduction in output of x-ray machines develops gradually, being due primarily to increasing inherent filtration as the tube operates. Occasional substantial and abrupt changes occur, however, which may remain undetected unless frequent measurements are made. Under such circumstances, justifiable anxiety may arise when clinical response is not as anticipated.

Preferably, x-ray output should be checked at least monthly, to permit prompt revision of treatment schedules should substantial changes occur. In many larger teaching institutions, residents perform such measurements as part of their training. When this is done, the instrument used should itself be checked at least annually, and serviced where indicated, or its accuracy may be lost. In smaller institutions, one rarely finds the busy radiologist carrying out this chore with any degree of consistency and regularity.

Monitor chambers (1) have been used for many years to check output constancy of deep-therapy machines. Earlier models employ large chamber volumes with copper plate electrodes; this design combination yields relatively large ionization currents, permitting direct galvanometer measurement, so that electronic amplifiers are not needed. Unfortunately, many machines cannot accommodate a large chamber in the tube housing assembly. Some newer commercial instruments therefore use small chambers with amplifiers. While these are generally of good design, they usually involve requirements of warm-up delay, zero setting, and occasional rather special-

[1] From Hahnemann Medical College and Hospital and Lankenau Hospital, Philadelphia, Penna. Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

ized service. Such units have frequently been encountered unused within a few years of installation, apparently for service reasons.

If results can be made accurate and meaningful, a film method may offer certain advantages in spot-checking machine output between calibrations. Tests could be scheduled regularly, with objective reports, in a manner similar to a film-badge service. Checking equipment supply and maintenance, as well as measurements themselves, would be the responsibility of an independent service. Obvious requirements are low cost, simplicity, and reliability of output measurement to ± 5 to 10 per cent.

This paper discusses the problems of developing such a film method. Procedures are suggested for assuring reproducibility of film density, and both the potentialities and limitations of the method are evaluated. Data are presented regarding change in x-ray output with kilovoltage and filtration at common treatment factors, as well as corresponding film response.

The accuracy of any film method is limited by two types of error. The first results from difficulties in obtaining reproducible film-density values. These may arise from variability of exposure, film sensitivity, and development, as well as densitometry errors. The second type involves uncertainties in correlating film-density changes with x-ray output variations. The magnitude and significance of these effects are discussed below.

## OBTAINING REPRODUCIBLE FILM DENSITY READINGS

The accuracy requirements of a roentgen output check are considerably greater than those of film badges. The density resulting from a single film exposure involves substantial variables of both sensitivity and development (2, 3). For this reason, a spot-check film should be exposed twice, to both the unknown and a known reference dosage; the ratio of measured densities then serves as a measurement of beam intensity. By means of such a procedure, development and film variations tend to cancel out, since all information is on a single film, and both images tend to be affected equally. Calibration is, of course, required to determine the actual roentgen dosage involved. The following operational procedure is proposed.

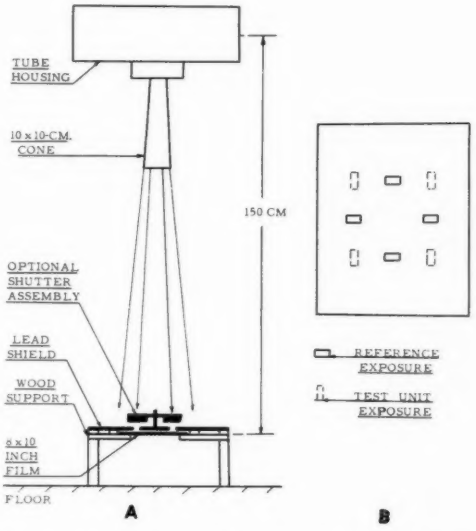


Fig. 1. A. Arrangement for exposure of test films. B. Areas exposed on test film.

At the time of machine calibration, the physicist alternately exposes small adjacent areas of a film to beams from two machines (Fig. 1). The first is a reference unit; a known dosage is used, corresponding to a film density of about 2.5. After calibration, the radiologist's machine is used to expose an adjacent portion of the same film, to about the same density. Development is carried out with minimum delay. The ratio of densities is then a measure of initial output of the machine.

At regular intervals (say, monthly), a film is sent to the radiologist for exposure. This has been previously exposed to radiation of the same dosage and quality from the reference machine as was employed on the first film. The same nominal dosage is now administered as at the time of calibration, and the film is returned

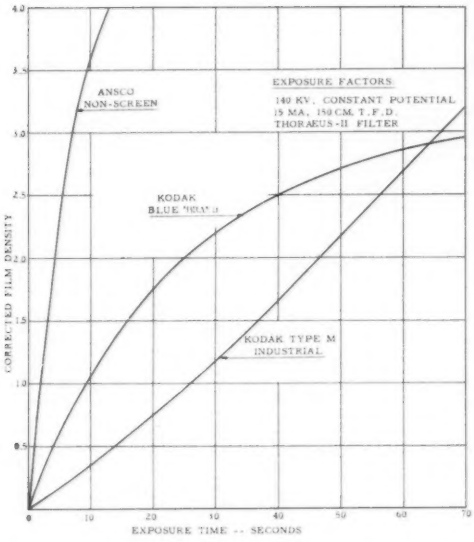


Fig. 2. Density *vs.* exposure time curves for the three x-ray film types.

promptly for development and density measurement. The new density ratio is a measure of the current dosage rate of the radiologist's machine; comparison with previous data provides a measure of radiation output.

Both output and quality of the reference machine must, of course, be accurately reproducible. If available, a cobalt-60 teletherapy machine provides an excellent reference beam. (An absorber of 3/16-inch Plexiglas in front of the film assures the required electron equilibrium.) Proper shielding of all but exposed areas must be done carefully; 4-inch lead brick assemblies (about 10 h.v.l.'s) have been found most effective.

Both medical and industrial films have been studied, for selection of the most suitable for this type of measurement. Figure 2 shows response curves of Kodak Blue Brand, Ansco Non-Screen, and Kodak Type M-industrial films, used in cardboard holders. Intensifying screens were avoided for two reasons. First, they introduce variables of contact, screen sensitivity, etc. Second, they increase film sensitivity, which is already excessively high, as discussed below. Both medical type films are very nonlinear at high densities; in their linear range, they are excessively sensitive. Similarly, while industrial films such as A and AA are quite linear (4–6), they are also too sensitive. Hence, Type M film was selected for reasons of both linearity and sensitivity.

Ideally, a five- to ten-minute film exposure, at 50 cm. target-film distance (TFD) would be desirable, to assure convenient reproducibility. Actually, even Type M film is much too sensitive for this. To increase times 9-fold, exposures are made at about 150 cm. target-film distance; this can usually be done by raising the tube head approximately as high as possible, with the film assembly about 6 inches from the floor (Fig. 1). Even under these circumstances, times range from four to sixty seconds. Table I shows typical

TABLE I: REQUIRED EXPOSURE TIMES TO YIELD FILM DENSITY OF 2.5 AT 150 CM. DISTANCE, FOR THREE MACHINES

| Kv | Filter | Approximate Exposure Times in Seconds for 2.5 Density | | |
|---|---|---|---|---|
| | | Constant Potential | Self-Rectified | Villard |
| 250 | Thoraeus III | 18 | 60 | .. |
| 250 | Thoraeus II | 10 | 28 | .. |
| 250 | 1.0 mm. Cu + 1.0 mm. Al | 5 | 16 | .. |
| 200 | Thoraeus II | 15 | 40 | 35 |
| 200 | 1.0 mm. Cu + 1.0 mm. Al | 6.5 | 26 | 17 |
| 200 | 0.5 mm. Cu + 1.0 mm. Al | 4 | 12 | 8 |
| 140 | 0.25 mm. Cu + 1.0 mm. Al | 5.5 | 15 | 10 |

required exposure times for densities of 2.5 with Type M film, at 150 cm. TFD. Data are given for all three wave form machines (constant, self-rectified, and Villard), for common kilovoltage and filter factors. Exposures of ten to thirty-five seconds are needed for the most useful factors, with the exception of 140 kvcp, 0.25 mm. Cu + 1.0 mm. Al filter. Since deep therapy machines usually have a "build-up time" of several seconds in impressing high voltage on the tube, it is

TABLE II: DATA REGARDING BEAMS USED TO MEASURE FILM RESPONSE OF KODAK TYPE M-INDUSTRIAL FILM

| Code # | Kv | Filter (mm.) | h.v.l. (mm.) | Effective kev | Type Machine | Location (All in Philadelphia) |
|---|---|---|---|---|---|---|
| 1 | 120 | 0.25 Cu + 1 Al | 0.44 Cu | 57.5 | Westinghouse | Lankenau Hospital |
| 2 | 120 | 0.5 Cu + 1 Al | 0.61 Cu | 65 | Constant potential | Lankenau Hospital |
| 3 | 180 | 0.25 Cu + 1 Al | 0.77 Cu | 71 | Constant potential | Lankenau Hospital |
| 4 | 180 | 0.5 Cu + 1 Al | 1.05 Cu | 81 | Constant potential | Lankenau Hospital |
| 5 | 180 | 0.78 Cu + 1 Al | 1.40 Cu | 91.5 | Constant potential | Lankenau Hospital |
| 6 | 180 | 1.35 Cu + 1 Al | 1.88 Cu | 105 | Constant potential | Lankenau Hospital |
| 7 | 250 | Thoraeus II | 2.65 Cu | 125 | Constant potential | Lankenau Hospital |
| 8 | 250 | Thoraeus III | 3.47 Cu | 149 | Constant potential | Lankenau Hospital |
| .. | 1650 | 0.1 in. Gold | 6.85 Pb | 780 | Van de Graaff | American Oncologic Hospital |
| .. | .. | ..... | 10.0 Pb | 1200 (est) | Cobalt-60 teletherapy* | Lankenau Hospital |

* Atomic Energy of Canada, Ltd., Theratron.

evident that a shutter of some kind is needed.[2]

Constant-potential machines are usually supplied with shutters; this assures reasonably good reproducibility of exposure, despite the high roentgen output rates of such units. Similarly, most Villard machines either have shutters or are designed to accommodate them. Unfortunately, many self-rectified machines do not have shutters and are apparently not readily modified for their installation. In such situations, the film-shield assembly (Fig. 1) may be provided with a manual lead shutter of adequate thickness (3/8 inch) mounted over the exposure openings. This could be a spring-driven clockwork device triggered by a string; at the end of the preset time, the ringing of a bell could signal the operator to terminate the exposure.

Although accurate data concerning film response are of obvious importance in dosimetry, coverage of this point in the literature has been rather limited (3–9). For the present purpose, a *family* of density *vs.* exposure dose curves is needed, rather than only one, since films are critically dependent on beam quality. Consequently, Type M-industrial film response was carefully measured at 10 beam qualities, ranging from 0.44 through 3.47 mm. Cu h.v.l. and up to cobalt-60 rays. (See Table II for description of these beams.) To obtain such curves, ten separate small exposures were made on the same 8 × 10-inch film, in increasing doses. Unexposed areas were carefully shielded. Back-scatter was greatly reduced by shielding objects beyond the film from all of the useful beam except the part traversing the small irradiated area. (Considerable scatter fogging results if this precaution is not taken.) The contribution of fogging was less than 0.1 density unit around areas exposed for as high as 4.5 density, even with film only 4 inches from a concrete floor.

Figures 3 to 6 inclusive give final results of these tests. The linearity of Type M film is seen to be excellent for corrected densities[3] of 0.5 to 3.0; it is somewhat poorer for supervoltage and cobalt-60 rays, for which good linearity is restricted to the 1.0 to 3.0 density range, an incidental finding of interest in supervoltage dosimetry.

The use of separate films for each quality of radiation introduces variability of development. To overcome this, all qualities were intercompared by exposing alternate areas of an individual film to two

[2] Ehrlich (2) has succeeded in reducing film speeds of a wide variety of films by enormous factors (10–100 times for x-ray films), using special developers. While this procedure apparently may adversely affect density consistency, it suggests the possibility of increasing exposure times to the point where shutters are no longer a necessity unless very high accuracy is required.

[3] Density is given corrected for emulsion and base absorption, which is about 0.135 density unit unexposed; this may increase to 0.23 adjacent to exposed areas, as a result of scatter fogging.

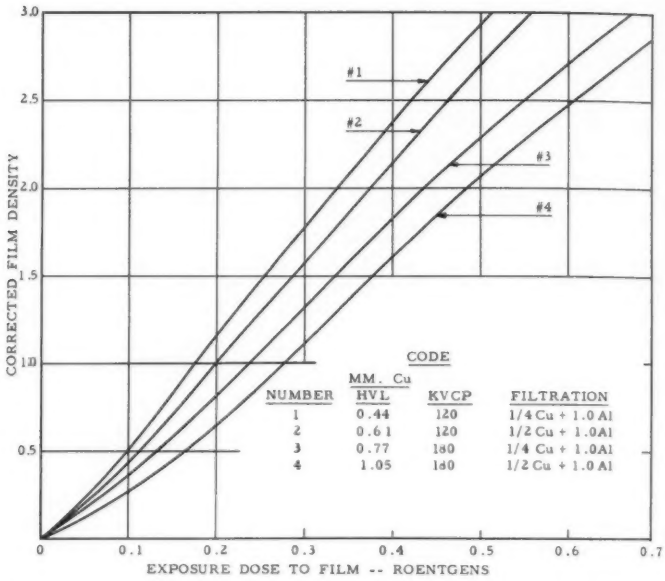
CORRECTED FILM DENSITY
EXPOSURE DOSE TO FILM -- ROENTGENS
#1
#2
#3
#4
CODE
NUMBER | MM. Cu HVL | KVCP | FILTRATION
1 | 0.44 | 120 | 1/4 Cu + 1.0 Al
2 | 0.61 | 120 | 1/2 Cu + 1.0 Al
3 | 0.77 | 180 | 1/4 Cu + 1.0 Al
4 | 1.05 | 180 | 1/2 Cu + 1.0 Al

Fig. 3. Corrected film density *vs.* exposure dose: qualities 1–4 inclusive.

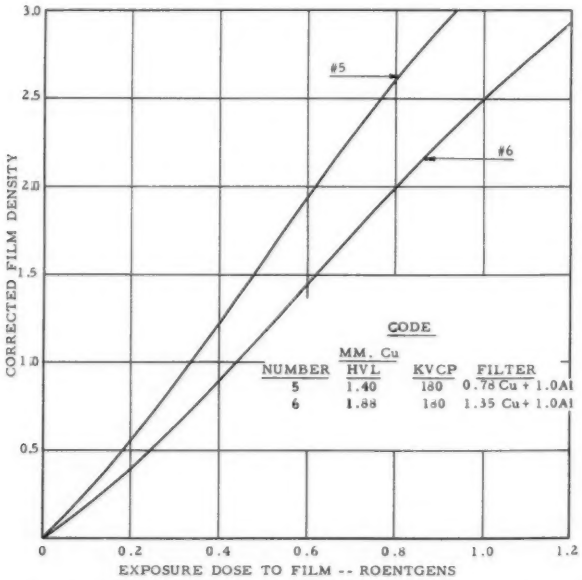
CORRECTED FILM DENSITY
EXPOSURE DOSE TO FILM -- ROENTGENS
#5
#6
CODE
NUMBER | MM. Cu HVL | KVCP | FILTER
5 | 1.40 | 180 | 0.78 Cu + 1.0Al
6 | 1.88 | 180 | 1.35 Cu + 1.0Al

Fig. 4. Corrected film density *vs.* exposure dose: qualities 5 and 6.

beams, thereby obtaining data for two curves on the same film. The curves of Figures 3 to 6 are thus self-consistent.

Figure 7 is a working curve for Type M film; it is derived from the data of Figures 3 to 6. Shown are the roentgen dosages required to produce film densities of 2.5 and 1.5, plotted as a function of the effective kev of incident radiation. In Figure 8, the 1.5 density data are replotted on a

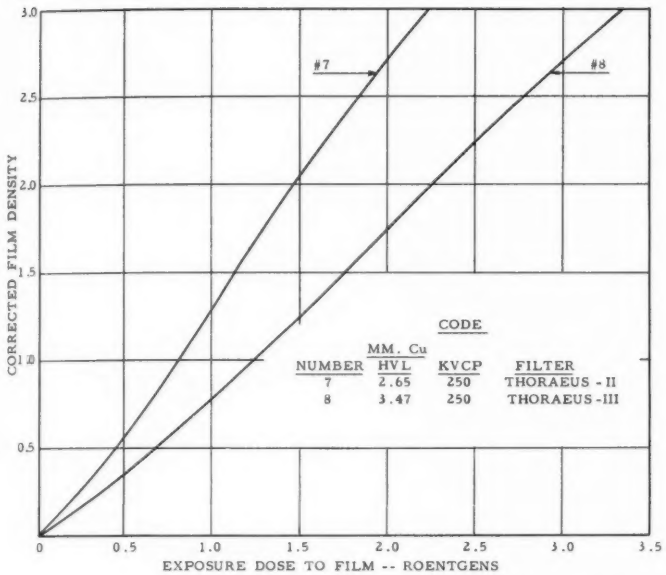


Fig. 5. Corrected film density *vs.* exposure dose: qualities 7 and 8.

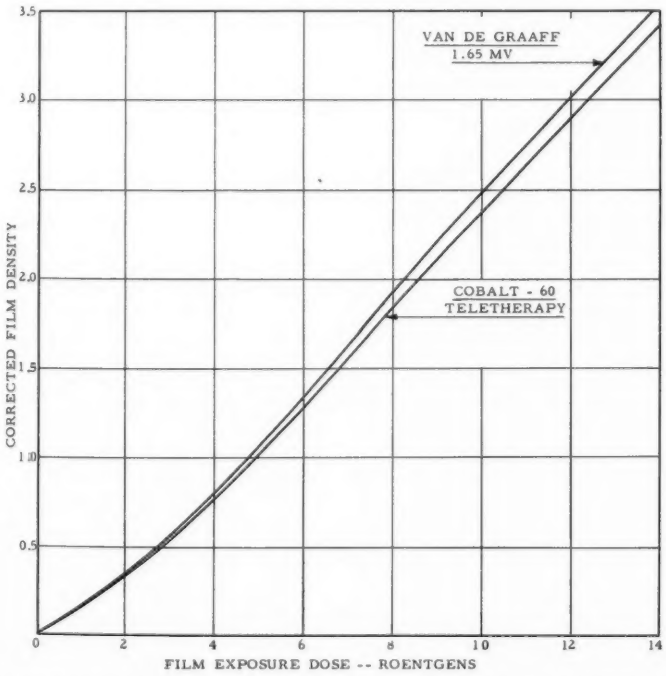


Fig. 6. Corrected film density *vs.* exposure dose: Cobalt-60 and 1.65 Mv Van de Graaff x-rays.

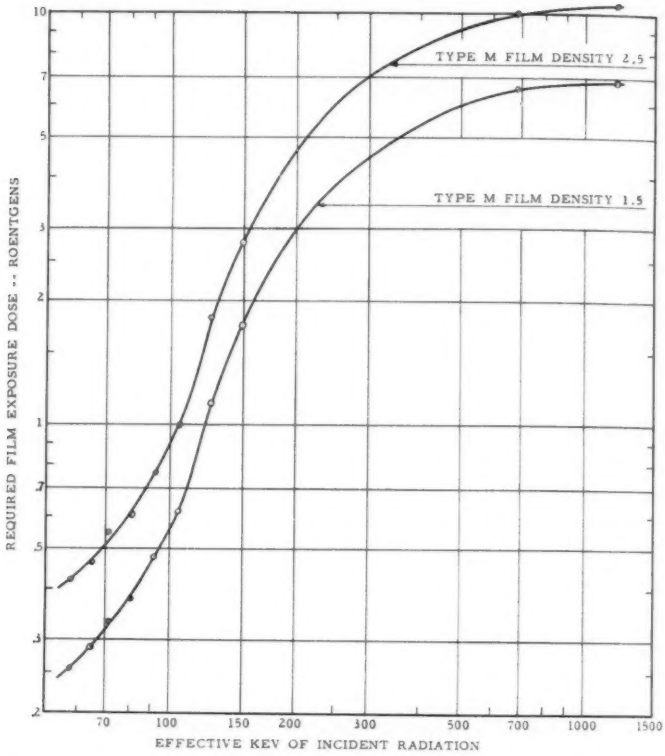


Fig. 7. Roentgen dose needed to produce corrected film densities of 2.5 and 1.5 *vs.* effective beam energy in kev.

different scale, taking that for cobalt-60 rays as unity. Wilsey and Greening's data for clinical films exposed to more heavily filtered beams are shown for comparison (7, 8). The great quality dependence of all x-ray films is confirmed; this is most critical in the 100 to 130-kev photon region (heavily filtered conventional x-ray beams); this fact will be shown below to be of crucial importance in setting up any x-ray constancy type dosimetry.

Film sensitivity varies slightly even over a single film (2). When isodensity lines were drawn from five Type M films receiving a constant x-ray exposure, variations in sensitivity of $\pm 2$ per cent were consistently observed. These appear to be attributable to normal production fluctuations of emulsions; in order to minimize the effect in monitoring x-ray output, several small areas are exposed at once and the resultant densities are averaged (Fig. 1).

Development problems are minimized in the proposed method by use of a reference exposure. It is important, however, to establish optimum development and density values for Type M film. Figure 9 shows curves of density *vs.* development time (new Kodak developer) for unexposed and three exposed areas of *the same film.* The following conclusions may be drawn from this test:

1. Density values above 3.0 should be avoided, to obtain consistent results. Both development and densitometry errors are probably involved.

2. Consistent corrected density ratios are found for development times of seven to thirteen minutes; serious deviations are observed beyond this range.

For checking machines, film densities

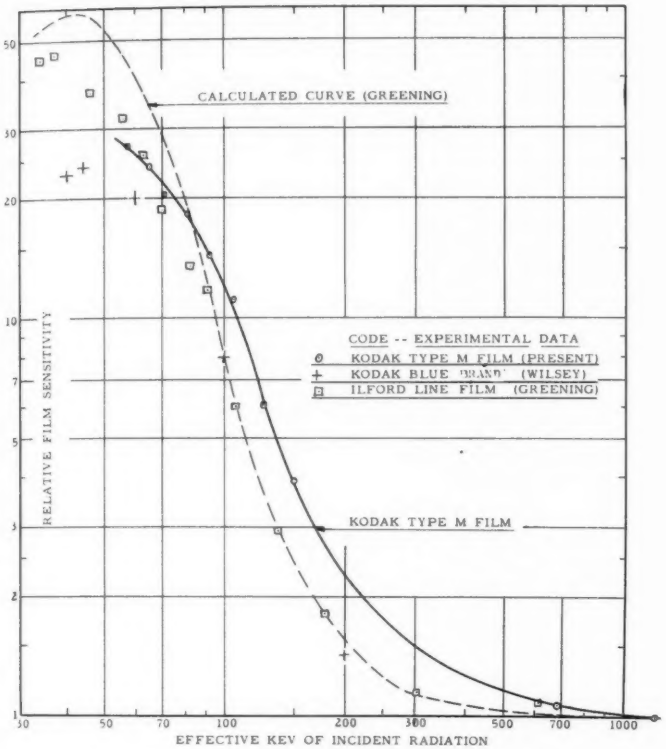


Fig. 8. Relative film sensitivity (density equals 1.5) *vs.* effective beam energy in kev. Cobalt-60 beam taken as unity.

of 2.5 were used; development was carried out for ten minutes in new or well maintained Kodak developer.

Film density is affected not only by the technic of development, but also by how soon it is done. McLaughlin and Ehrlich have shown that for some film types the latent image may fade substantially in a matter of days (10). In the present application, the two exposures are made at different times, so that a difference in fading occurs. To evaluate this effect, ten identical roentgen exposures were made on each of several films, scheduled from one hour to twelve days before development. Three film types were tested, each at two density levels (1.5 and 3.0, approximately). Storage was at about 80°F., on a shelf in a dry atmosphere. Figure 10 shows resulting curves of relative density *vs.* delay. No simple relationship between density and time is observed. After a slight initial tendency to rise, density diminishes to a minimum value in eight or nine days, followed by substantial recovery. Greater per cent changes occur for low than for high densities, with Type M and nonscreen film. Blue Brand data are not greatly affected by density; this is probably due to its saturation (Fig. 2) at the density values measured.

In practice, little density variation is observed with M film in the first seventy-two hours; later, a rapid steady drop occurs, up to one hundred seventy hours. For this reason, it is recommended that films be developed within three to six days after exposure. If exposure times are recorded on the film envelope, appropriate corrections may be made for latent image fading.

Film densities have been read on a

TABLE III: ERROR INVOLVED WHEN CHANGE IN FILM DENSITY IS ASSUMED TO BE DIRECT MEASURE OF CHANGE IN ROENTGEN OUTPUT

| Kv | Filter (mm.) | Film Density Change (per cent) | Error in Roentgen Output: Constant Potential ΔF (%) | Constant Potential ΔV (%) | Self-Rectified ΔF (%) | Self-Rectified ΔV (%) | Villard ΔF (%) | Villard ΔV (%) |
|---|---|---|---|---|---|---|---|---|
| 250 | Thoraeus III | 5 | −1.5 | 4.5 | −2.5 | 2.8 | ... | .. |
| 250 | Thoraeus III | 10 | −3.2 | 8.0 | −5.0 | 5.5 | ... | .. |
| 250 | Thoraeus III | 15 | −5.0 | 11.0 | −7.3 | 8.0 | ... | .. |
| 250 | Thoraeus III | 20 | −7.1 | 13.0 | −9.5 | 10.5 | ... | .. |
| 250 | Thoraeus II | 5 | −2.4 | 5.0 | −2.8 | 2.3 | ... | .. |
| 250 | Thoraeus II | 10 | −4.8 | 8.5 | −5.5 | 4.5 | ... | .. |
| 250 | Thoraeus II | 15 | −7.5 | 11.0 | −8.2 | 6.8 | ... | .. |
| 250 | Thoraeus II | 20 | −10.0 | 14.0 | −11.0 | 9.0 | ... | .. |
| 250 | 1 Cu + 1 Al | 5 | −2.4 | 6.0 | −2.8 | 2.0 | ... | .. |
| 250 | 1 Cu + 1 Al | 10 | −4.7 | 9.5 | −5.5 | 4.0 | ... | .. |
| 250 | 1 Cu + 1 Al | 15 | −7.0 | 12.0 | −8.2 | 5.7 | ... | .. |
| 250 | 1 Cu + 1 Al | 20 | −9.6 | 13.5 | −11.0 | 7.5 | ... | .. |
| 200 | Thoraeus II | 5 | −2.6 | 2.5 | −2.5 | 4.2 | −2.2 | 1.7 |
| 200 | Thoraeus II | 10 | −5.3 | 5.0 | −5.0 | 6.0 | −4.5 | 3.5 |
| 200 | Thoraeus II | 15 | −7.7 | 7.0 | −7.4 | 5.5 | −6.7 | 5.3 |
| 200 | Thoraeus II | 20 | −9.8 | 8.0 | −9.8 | 5.0 | −8.9 | 6.7 |
| 200 | 1 Cu + 1 Al | 5 | −2.5 | 1.8 | −3.3 | 1.8 | −1.1 | 3.7 |
| 200 | 1 Cu + 1 Al | 10 | −4.7 | 4.2 | −4.5 | 3.0 | −2.5 | 6.5 |
| 200 | 1 Cu + 1 Al | 15 | −6.7 | 5.5 | −6.8 | 3.5 | −4.2 | 8.5 |
| 200 | 1 Cu + 1 Al | 20 | −9.0 | 9.5 | −9.0 | 4.0 | −6.0 | 10.0 |
| 200 | 1/2 Cu + 1 Al | 5 | −2.3 | 2.5 | −1.8 | 1.5 | −0.3 | 1.3 |
| 200 | 1/2 Cu + 1 Al | 10 | −4.4 | 4.8 | −3.5 | 3.0 | −1.2 | 2.5 |
| 200 | 1/2 Cu + 1 Al | 15 | −6.5 | 4.5 | −5.2 | 4.1 | −3.0 | 4.0 |
| 200 | 1/2 Cu + 1 Al | 20 | −8.5 | 4.6 | −7.0 | 4.2 | −4.9 | 5.1 |
| 140 | 1/2 Cu + 1 Al | 5 | −2.1 | 3.0 | ... | .. | ... | .. |
| 140 | 1/2 Cu + 1 Al | 10 | −3.6 | 5.0 | ... | .. | ... | .. |
| 140 | 1/2 Cu + 1 Al | 15 | −5.3 | 6.3 | ... | .. | ... | .. |
| 140 | 1/2 Cu + 1 Al | 20 | −6.9 | 7.3 | ... | .. | ... | .. |
| 140 | 1/4 Cu + 1 Al | 5 | −2.2 | 2.0 | −1.7 | 1.5 | −1.2 | 0.1 |
| 140 | 1/4 Cu + 1 Al | 10 | −3.5 | 3.0 | −3.2 | 3.0 | −2.5 | 0.5 |
| 140 | 1/4 Cu + 1 Al | 15 | −5.2 | 4.0 | −4.8 | 4.4 | −3.7 | 1.7 |
| 140 | 1/4 Cu + 1 Al | 20 | −6.5 | 4.7 | −6.4 | 5.7 | −5.0 | 3.0 |

*Photovolt* transmission densitometer using a 1 × 4-mm. slit area. The instrument was quite reliable when the meter zero and electrical zero were both carefully set and film densities did not exceed 3.0. Under these circumstances, readings were self-consistent and reproducible to ±1 per cent of measured density or .01 density unit, whichever was greater.

## CORRELATION OF FILM DENSITY AND X-RAY OUTPUT

From the above discussion, it would appear possible to reproduce film density values with reasonable accuracy, using practical procedures and equipment. Unfortunately, the interpretation of measured changes in film density is complicated by the fact that x-ray machine *quantity* changes are normally accompanied by *quality* changes. Since films are critically dependent on beam quality, measured densities are therefore affected by both factors.

In most cases, increased inherent filtration causes the observed drop in output. This is accompanied by a hardening of the beam, due to preferential removal of softer components. The output change tends to reduce the density roughly proportionally (Figs. 3 to 6); in addition, however, the film is now irradiated by a harder beam, to which it is less responsive. As a result, the extent of the output reduction is exaggerated by the film density measurement. On the other hand, should a drop

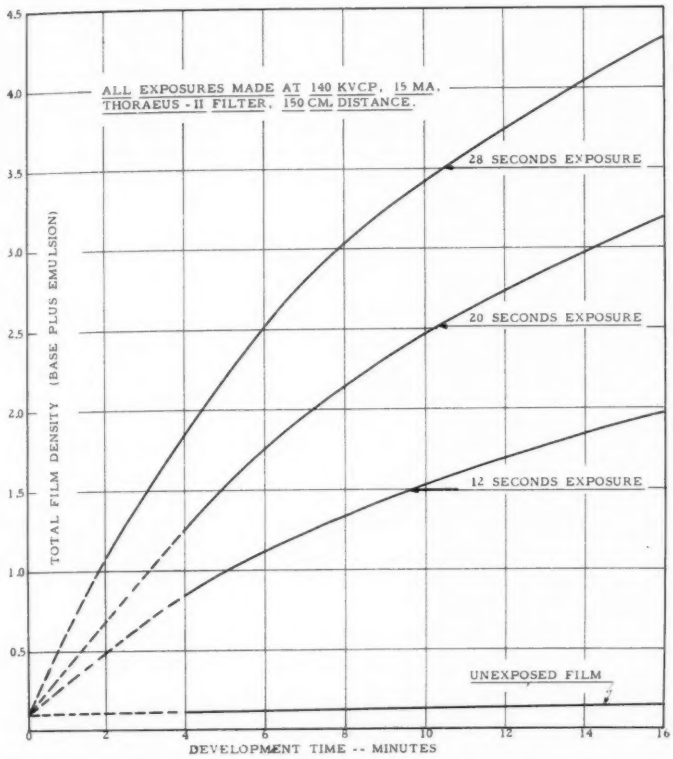


Fig. 9. Total film density *vs.* development time (same film in all cases). Four curves: unexposed and twelve, twenty, and twenty-eight second exposures.

in kilovoltage be the precipitating cause of an output change, the beam is softened by the greater removal of higher energy components. Since films are more sensitive to soft than hard radiation, the film density change indicates a smaller than actual output change.

It is hence evident that a given observed film density change cannot be a unique measure of the output change unless the nature of the precipitating cause is known. To illustrate, for a 250-kvcp, Thoraeus II beam, a 10 per cent low density reading (Type M film) can result from *either* (*a*) 6.2 per cent reduction in roentgen output due to increased filtration or (*b*) 18.5 per cent reduction in roentgen output due to a kilovoltage decrease.

To evaluate the applicability of the film method, a study was made of the dependence of machine roentgen output and film density on both kilovoltage and filtration. This has been done for constant potential, self-rectified, and Villard machines, for most frequently used treatment factors. Only the constant potential data are included here. Figure 11 shows the variation in output (solid) and Type M film density (dotted curves), with kilovoltage changes. Similar data are shown in Figure 12 for variation with added filter.

Table III has been computed from the above data. This shows the errors involved when film density changes are assumed to provide a direct measure of roentgen output. The actual output change may be found by adding the indicated error to the observed film density change. The ΔF columns apply when the precipitating cause is added filtration; the ΔV columns, for reduction in kilo-

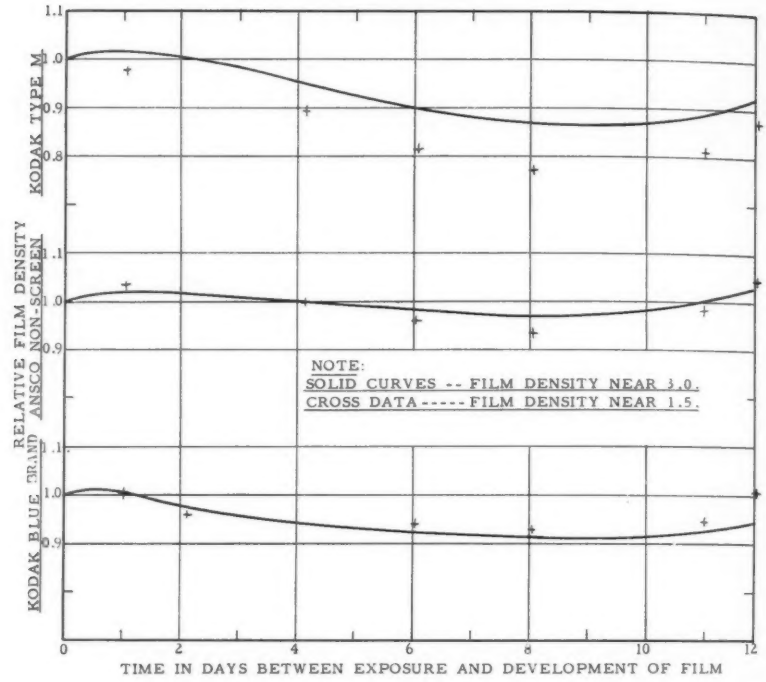
RELATIVE FILM DENSITY
KODAK TYPE M
KODAK BLUE BRAND ANSCO NON-SCREEN
NOTE:
SOLID CURVES -- FILM DENSITY NEAR 3.0.
CROSS DATA ----- FILM DENSITY NEAR 1.5.
TIME IN DAYS BETWEEN EXPOSURE AND DEVELOPMENT OF FILM

Fig. 10. Dependence of film density on time between exposure and development: image fading.

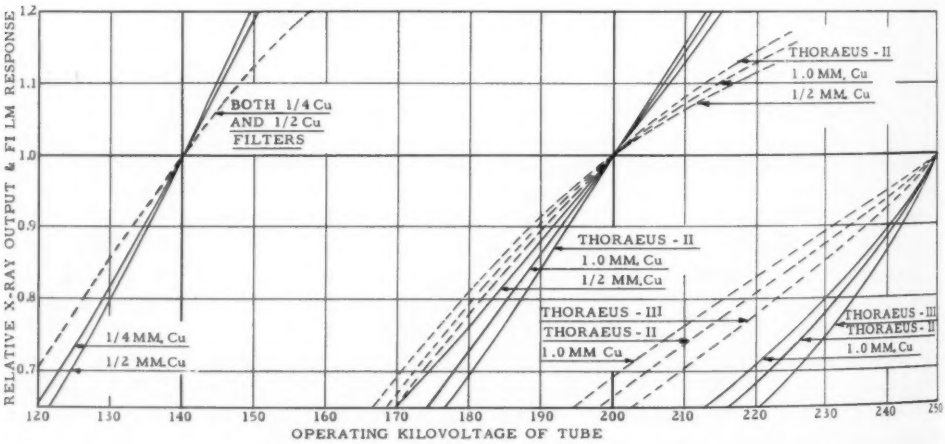


Fig. 11. Variation of roentgen output and Type M film density with *falling kilovoltage:* constant-potential machine.

voltage. It is noted that errors tend to increase with beam hardness, corresponding to maximum film energy dependence mentioned before in the 100 to 130 kev region (Fig. 8). The method offers most promise in the monitoring of 140-kv beams, as well as lightly filtered Villard units, due to their lower photon energies.

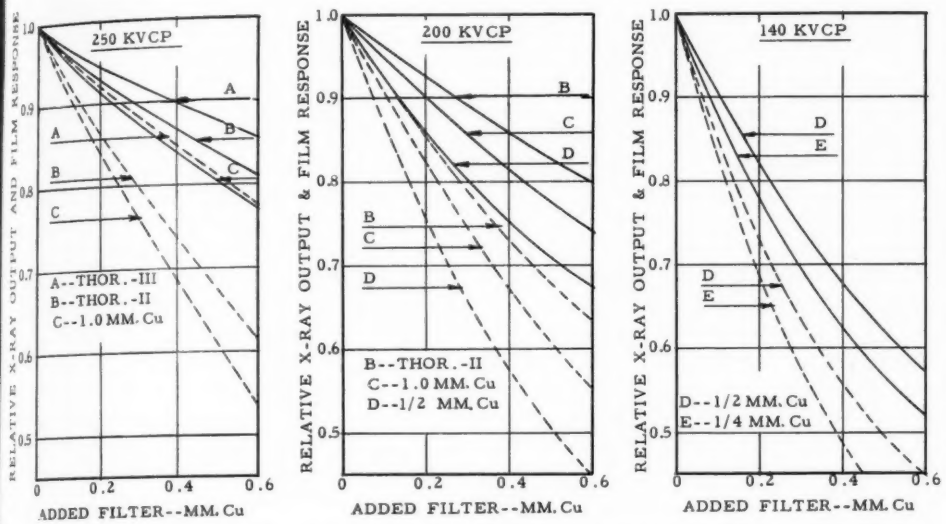


Fig. 12. Variation of roentgen output and type M film density with *increasing filtration:* constant-potential machine.

## SUMMARY AND CONCLUSIONS

The need for regular monitoring of x-ray therapy machines is discussed and the limitations of existing procedures indicated, with the potential advantages of a satisfactory film method. Basic problems of reliably reproducing film density are analyzed, and methods suggested which potentially assure accuracy of density readings with practical procedures. Experimental data are presented relating to film sensitivity, energy dependence, and development.

The following conclusions are reached:

1. The several variables contributing to inaccuracy of film density can apparently be controlled with proper materials, equipment, and procedures. Were this the only problem, a monitoring method might be evolved without great difficulty.

2. An unexpected ambiguity of interpretation of film density readings exists. This limits the use of films as x-ray output monitors to situations where the precipitating output cause is reasonably identifiable, or where low-energy beams are employed.

ACKNOWLEDGMENT: The writer expresses his appreciation to Hahnemann Medical College and Hospital and Lankenau Hospital for their support of this work, and to the American Oncologic and University of Pennsylvania Hospitals, which made their supervoltage units available for some of the tests.

Hahnemann Medical College and Hospital
Philadelphia 2, Penna.

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*(Pro le summario in interlingua, vider le pagina sequente)*

SUMMARIO IN INTERLINGUA

**Problemas in le Elaboration de Un Methodo a Pellicula pro le Controlo Regular del Rendimento de Radiation de Apparatos de Radios X**

Le rendimento in roentgens de un apparato de radios X varia grandemente con le kilovoltage, le inherente filtration del tubo, e certe factores miscellanee.

Il es recommendabile que le rendimento de radios X es mesurate al minus un vice per mense pro render possibile le prompte revision del programmas de tractamento in caso que importante alterationes ha occurrite. Pro iste objectivo cameras de controlo es in uso depost longe tempores, sed il pare plausibile opinar que un methodo a pelliculas esserea preferibile pro tests aleatori del rendimento del apparato inter le tempores del calibration. Tal tests pote esser effectuate regularmente con reportos objective, in un maniera simila a un servicio de pelliculas-placa.

Le accuratia de omne methodo a pelliculas es restringite per duo typos de error. Le prime resulta del difficultate de obtener reproducibile valores de densitate de pellicula a causa del variabilitate del expositiones, del sensibilitate del pellicula, e del diveloppamento, e etiam a causa de errores densitometric. Le secunde concerne le incertitudes del correlation inter alterationes in le densitate del pelliculas e variationes in le rendimento de radios X. Iste problemas es analysate, e proponimentos es facite pro lor solution.

Es concludite que accuratia de densitate del pellicula pote esser effectuate con le uso de appropriate materiales, apparaturas, e technicas. Il existe un inexpectate ambiguitate in le interpretation del lecturas del densitate del pellicula, como resultato de lor extreme dependentia del energia. Isto reduce le uso de pelliculas como medios de controlo del rendimento a situationes in que le causa precipitatori del rendimento es sensibilemente identificabile o in que fasces de energia de 10 w es empleate.

# The Roentgen Appearance of Benign Osteoblastoma[1]

RUBEM POCHACZEVSKY, M.D., YING MING YEN, M.D., and ROBERT S. SHERMAN, M.D.

THIS PAPER RECORDS an attempt to determine the roentgenologic features of benign osteoblastoma through a review of the literature and personal experience with 4 new cases of this uncommon and interesting bone tumor. Two writers (1, 3) state that this neoplasm has no characteristic roentgen appearance, while another (6) holds an opposite opinion. There has been no review of a representative volume of cases in an attempt to resolve these differences.

Histologically, benign osteoblastoma is characterized by the presence of well vascularized osteoid and bone-forming tissue which bears a certain similarity to osteoid osteoma (3). However, benign osteoblastoma differs significantly both clinically and roentgenographically from the classical osteoid osteoma (3, 6).

To date there have appeared in the literature about 30 cases of benign osteoblastoma (1–6). Lichtenstein (6) carefully analyzed the material reported by Dahlin and Johnson (1) under their designation "giant osteoid osteoma." It was his opinion that most of their cases were without doubt benign osteoblastomas and that only a few could be interpreted as genuine osteoid osteomas. A study of the roentgenographic reproductions in Dahlin's cases, in our opinion, lends support to Lichtenstein's view. It appears that at least 7 are acceptable examples of benign osteoblastoma according to the criteria outlined by Jaffe (3). Golding and Sissons (2) reported 2 cases, and Kirkpatrick and Murray (5) reported another, under the heading "osteogenic fibroma." Jaffe published 10 cases and Lichtenstein an equal number.

As pointed out by Jaffe and Lichtenstein, the name benign osteoblastoma is a suitable designation for this uncommon neoplasm of bone. It should not be confused with the so-called "ossifying fibroma" which is apparently closely related to fibrous dysplasia and usually localized in the maxilla or the mandible (3).

Benign osteoblastoma is a neoplasm which is usually adequately treated either by conservative surgery, *e.g.*, curettage or radiation therapy. Of the 30 cases reported many have been followed for relatively long periods of time—six years (2), ten years (3), and fourteen years (1), all without recurrence. In only 1 case, which was described by Lichtenstein, was recurrence observed. This took place after an interval of nine years.

Despite its benign nature, the tumor is an actively growing neoplasm which can give rise to serious consequences. For example, local compression of neighboring structures, when the location is in the spine, can produce neurologic syndromes due to pressure on the cord (1–6). The most common clinical complaints are dull, insidious pain and local tenderness, accompanied by a soft-tissue swelling. Associated swelling of adjacent joints was reported in 2 cases (1). The duration of symptoms is usually only a few months (3). Jaffe and Mayer (4), however, described a case in which growth of the tumor was observed for about two and a half years, Lichtenstein mentions 2 cases in which symptoms were of two years duration, and Dahlin and Johnson had a patient with symptoms referable to the neoplasm for about four years.

The majority (75 per cent) of the reported cases were in persons below twenty years of age, the peak incidence being between ten and twenty. The youngest patient was a five-year-old boy and the oldest was a sixty-year-old man (1). No significant sex difference is discernible.

Roentgenograms of 16 of the 30 benign osteoblastomas reported in the literature

[1]From the Department of X-Ray Diagnosis, Memorial Center and James Ewing Hospital, New York, N. Y. Accepted for publication in December 1959.

were reproduced (1–6). In an additional 3 (1, 2), direct reference to the radiological findings was made, although the films were not shown. In almost all of these tumors the process was predominantly osteolytic, but there was radiologic evidence also of bone production or calcification of varying degree within the tumor. Only one purely osteolytic lesion without any apparent bone production or calcification was noted (1).

In most instances, an expanding type of defect which produced cortical erosion was noted, so that in only 2 was the cortex apparently intact (6). A soft-tissue mass arising from the eroded cortex was noted in about two-thirds of the cases. In at least half, a definite calcific shell of quite characteristic nature, sharply delimiting the soft-tissue mass, was clearly seen (2, 3, 5, 6). In general, the tumor was well demarcated from the normal neighboring bone. In only one benign osteoblastoma (6) was there a roentgen appearance vaguely resembling the so-called "nidus" which is so characteristic of osteoid osteoma.

A pathological fracture was noted once (3), and only once (4) was a periosteal reaction observed. A periosteal reaction was present, however, in adjacent bones which were subjected to pressure from the expanding tumor, but this cannot be considered as an x-ray finding of the tumor itself. Actual growth of the neoplasm was observed radiologically twice. Once (4) the tumor increased markedly in size in a period of two and a half years, and in the other (1) a significant increase in size was noted in a period of eight months.

As far as location in the skeleton is concerned, it is of interest to note that in more than half of the cases in which the exact site of the tumor was described, it was in the vertebral column. The neural arch was the favored region, and the pedicle in most instances was also invaded. Only when the tumors reached considerable size were the vertebral bodies involved. This occurred in 3 cases (1). The second most frequent location (a fifth of the total) was the long bones, where the tumor was identified as equally distributed between the ends and the shaft. It was located at the metaphysis once (6) but did not cross the epiphyseal line. Many of the tumors involved the small bones (see Table I). Most appeared to have had an eccentric origin.

TABLE I: BENIGN OSTEOBLASTOMA: LOCATION OF THE TUMOR IN 28 CASES

| | Cases |
|---|---|
| Vertebral column | 15 |
| Thoracic spine (1, 1, 2, 5, 6) | 5 |
| Lumbar spine (1, 1, 1, 2) | 4 |
| Cervical spine (3, 6, 6) | 3 |
| Sacrum (3, 3, 3) | 3 |
| Long bones | 6 |
| Tibia (3, 6) | 2 |
| Fibula (3) | 1 |
| Femur (6) | 1 |
| Radius (6) | 1 |
| Humerus (1) | 1 |
| Metacarpal (3, 3) | 2 |
| Talus (1) | 1 |
| Rib (3) | 1 |
| Scapula (3) | 1 |
| Patella (1) | 1 |
| Calvaria (6) | 1 |
| | 28 |

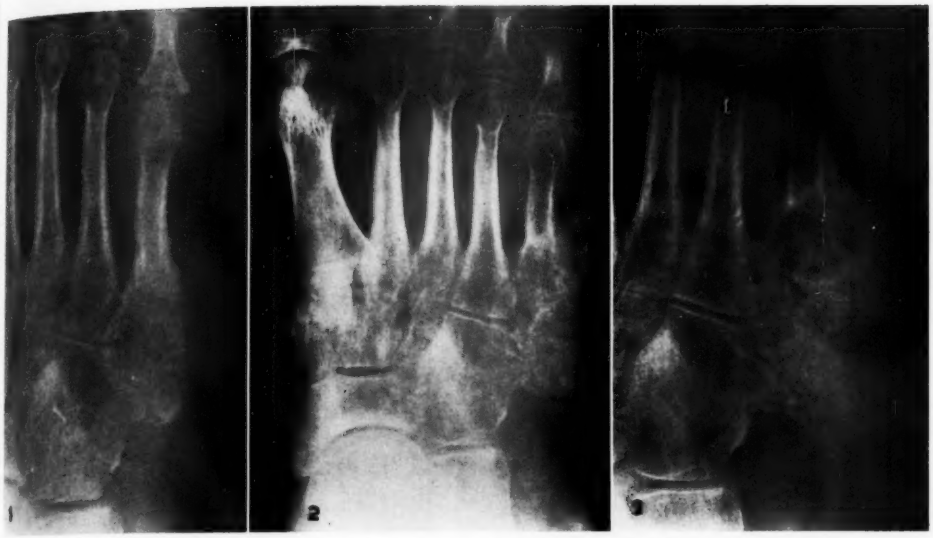
The size of the tumor appears to be variable, dependent on its duration. The smallest one, reported by Jaffe, measured 2 × 1.5 × 6 cm. and was situated in the fibula. Another reported by Jaffe was in the sacrum, with a diameter of 7.0 cm. The largest tumor was described by Jaffe and Mayer, 10 × 6.5 × 6 cm. This involved a metacarpal bone. The average size when the patient was first seen was approximately 2 to 3 cm. diameter.

In 3 reports (3, 5, 2) roentgenograms obtained before and after radiation therapy were reproduced. All of them showed extensive calcification following treatment.

## PRESENTATION OF CASES[2]

CASE I: Y. P., a 28-year-old housewife, seven months pregnant, was first seen on Feb. 28, 1954, because of a swelling on the dorsum of the left foot of six months duration. The patient dated her illness from October 1953, when she "sprained" her left ankle. At that time swelling of the outer aspect of the foot was noted, and, in spite of treatment with ice packs and rest, this persisted. A bluish dis-

[2] In these reports those aspects of special significance in roentgen diagnosis are emphasized. All patients were operated upon by members of the Bone Service, Memorial Center, Kenneth C. Francis, M.D., Chief.



Figs. 1–3. Case 1. Benign osteoblastoma at the base of the left fifth metatarsal.
Fig. 1. Early osteolytic changes.
Fig. 2. Significant increase of the expanding osteolytic process which involves almost the entire proximal half of the left fifth metatarsal. An ovoid soft-tissue mass, measuring about 3 × 2 cm., is associated with the bone destruction. Fine radiopaque specks are noted within this mass, which is sharply circumscribed by a calcific shell.
Fig. 3. Further increase in the growth of the tumor.

coloration of the dorsum of the foot was also present.

The patient saw her local physician in January 1954, and roentgenograms of her foot were taken for the first time. On the basis of the x-ray findings, a biopsy of the lesion was performed, which was reported as "benign giant-cell tumor."

The submitted films of the foot, dated Jan. 8 and Feb. 17, 1954, showed osteolytic changes at the base of the fifth metatarsal bone (Fig. 1), with an increase in the destructive process over the period represented. There was medullary expansion of the bone, and a slight soft-tissue swelling was also present. The joint space was not involved. Osteoporosis was seen in the other bones of the foot. These findings were reported as compatible with the pathological diagnosis of benign giant-cell tumor.

An x-ray examination on May 25 (Fig. 2) showed a significant increase of the expanding osteolytic process, which now involved almost the entire proximal half of the metatarsal. There was some destruction of the cortex. The lesion, however, was well delimited from the normal bone. A slight periosteal reaction was present along the shaft of the involved metatarsal. An ovoid soft-tissue mass, measuring about 3 × 2 cm., was associated with the bone destruction. Fine radiopaque confluent specks were noted within this mass, which was sharply circumscribed by a delicate calcific shell. The demineralization of the bones of the foot persisted. The findings were again interpreted as consistent with benign giant-cell tumor. However, because of the rapidity of growth and the extreme degree of bone destruction, it was felt that a malignant lesion could not be excluded roentgenologically.

Allowed to go to term, the patient had a normal delivery, and on July 21 was admitted for definitive treatment of the lesion of the foot. Films taken on this admission (Fig. 3) showed further growth of the tumor. Physical examination revealed some progression in the size of the swelling. The lateral half of the dorsum of the foot was enlarged in a smooth and regular fashion, with normal appearing toes and ankle. The area was smooth, firm, and nontender, revealing no nodularity on palpation. Motion of the subastragalar joint was unimpaired and not painful. Blood chemistry was within normal limits, except for an alkaline phosphatase of 8.7 units (July 22), which subsequently dropped to a normal level. This elevation was considered to be related to the recent pregnancy.

On July 22 a local removal of the tumor was performed. The fifth metatarsal was excised in its entirety, along with the digit. A portion of the cuboid was also removed because of pressure necrosis, which was attributed to the tumor. A bulky mass occupied the entire proximal three-fourths of the fifth metatarsal. This mass had expanded and destroyed the cortex of the bone but appeared to be largely encapsulated by fibrous tissue. No tumor tissue was encountered in the excised area from the cuboid. In short, there did not appear to be local extension of the tumor beyond its capsule at any point.

Fig. 4. Case II. Benign osteoblastoma produciug a destructive process involving the cortex of the anterior surface of the talus. Arising from this destructive process is a round soft-tissue mass about 1.5 cm. in diameter. Within this mass irregular faint calcific specks were noted.

The pathological specimen consisted of a block of tumor tissue measuring 6 × 3 × 3 cm. The lesion was speckled throughout with gritty, bony fragments and apparently had been removed in its entirety. There were areas of scattered hemorrhage and lymphoid-appearing tissue within the mass. The first pathological diagnosis was osteogenic sarcoma. Later, benign chondroblastoma[3] was also considered. When the slides were subsequently reviewed, however, the diagnosis was stated to be benign osteoblastoma by Dr. F. W. Stewart. To date, there has been no clinical or radiological evidence of recurrence.

*Comment:* Illustrated are some of the pitfalls in the diagnosis of this tumor of bone. Radiologically, it was characterized by a malignant looking, expanding osteolytic lesion, which increased rapidly in size, as shown by serial films during a period of seven months. The neoplasm had destroyed the cortex of the bone and was associated with an enlarging soft-tissue mass which, however, was clearly delimited by a thin calcific shell. There were also serious difficulties in the histologic identification of the tumor, with a range of opinion from benign giant-cell tumor and benign chondroblastoma, to the ominous diagnosis of osteogenic sarcoma. An important clue to the radiologic diagnosis might have been the presence of a well delimited calcific shell and the innumerable fine irregular calcific specks within the soft-tissue mass.

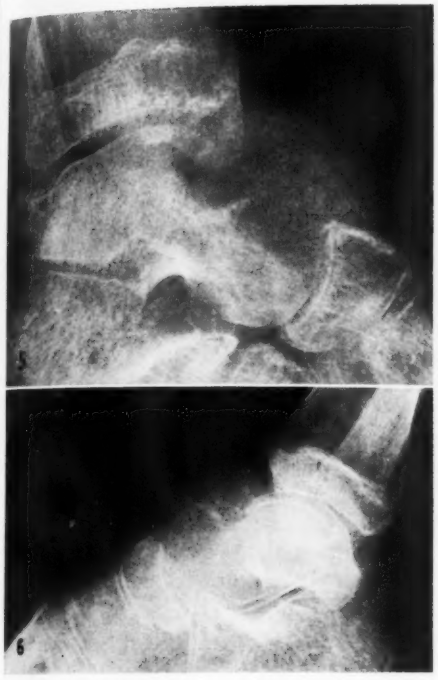
CASE II: D. S., a 12-year-old girl (patient of Dr. Norman L. Higinbotham), was admitted on Oct. 27, 1957, with a history of pain and swelling which was attributed to twisting the left ankle two and a half months previously. The injury was treated conservatively until roentgenograms obtained several weeks later showed a lytic area in the left talus. This lesion was biopsied and reported initially as chondrosarcoma, but later was correctly diagnosed as benign osteoblastoma. On examination, the left ankle was swollen in the region of the medial malleolus and the area was moderately tender.

The submitted films, dated Sept. 16 (Fig. 4), showed a destructive process involving the cortex of the anterior superior surface of the talus. Arising superiorly from the area of destruction was a round soft-tissue mass about 1.5 cm. in diameter. Within this mass irregular faint calcific specks were noted.

Examinations of Oct. 19 and Oct. 22 (Fig. 5) showed definite progression of the osteolytic process, which involved an area measuring 3 × 1 cm. in the superior aspect of the talus, destroying its cortex. Associated with the bone involvement was a 2.5-cm. calcified soft-tissue mass, sharply circumscribed by a thin calcific shell and containing small, faint, irregular calcific deposits, giving it a fairly uniform increase in density.

Films obtained on Nov. 13 (Fig. 6) showed a significant increase in the osteolytic process, which almost completely destroyed the superior surface and the anterior third of the talus. The soft-tissue mass arising from the superior surface of the talus now measured approximately 3.5 cm. in diameter and was still delimited by a calcific shell. Flecks of calcification were still seen within this mass. Demineralization in the distal tibia and in the bones of the foot was also present, probably on the basis of disuse. The ankle joint was markedly swollen. The roentgenologist's impression was a malignant tumor, such as osteogenic sarcoma.

[3] This pathological diagnosis led to the inclusion of this case in a study of the roentgenographic appearance of benign chondroblastoma of bone (7).



Figs. 5 and 6. Case II.

Fig. 5. Definite progression of the osteolytic process which involves an area of 3 × 1 cm. in the talus, destroying its cortex. Associated with the bone involvement is a 2.5-cm. soft-tissue mass, sharply circumscribed by a thin calcific shell. Small, faint, irregular calcific densities are again seen within this soft-tissue mass.

Fig. 6. Significant increase in size of the tumor within a month.

The blood chemistry determinations were normal: calcium, 10.4 mg. per cent; alkaline phosphatase, 4.9 units; inorganic phosphorus, 4.70 mg. per cent; total protein: 7.3 gm.

At operation, on Nov. 18, a 3 × 4 × 4-cm. bluish, encapsulated, moderately firm, rather hemorrhagic tumor was found just underneath the skin. It extended down through the cortex into the body of the talus, with destruction of the major part of the anterior and inferior portion of that structure, leaving only a thin shell of periosteum. Curettage of the bone cavity and packing with bone chips were performed.

The pathologic specimen was described as an ovoid mass of gray tissue 5 cm. in its greatest diameter, containing innumerable evenly arrayed flecks of calcific material. The intervening tissue was gray to pink and firm. A thin plate of bone 1.5 cm. in diameter was adherent to one surface. The microscopic diagnosis was benign osteoblastoma.

The patient had an uneventful postoperative course and continues to show an excellent result, without evidence of recurrence.

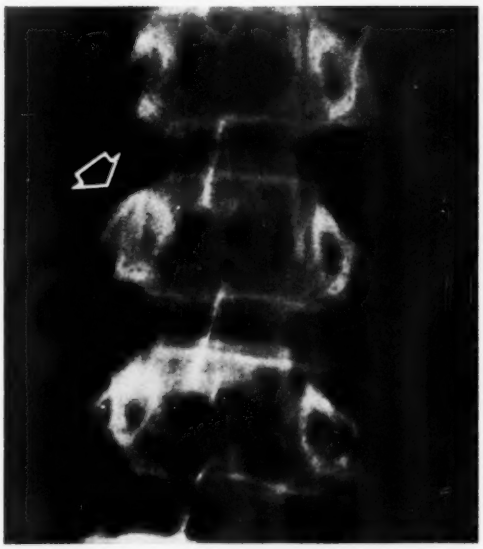


Fig. 7. Case III. The right pedicle of L-2 appears to be slightly enlarged and indistinct in outline and there is a suggestion of early destruction of the right margin of the body of L-2. This film was made eleven months before admission.

*Comment:* This is another case in which the roentgenologic appearance was thought to be that of a malignant tumor, with destruction of the bony cortex, associated with a large soft-tissue mass clearly delimited by a calcific shell. Myriads of faint specks of calcification were again noted, producing a stippled mass of increased density.

CASE III: C. P., a-12-year-old boy (patient of Dr. Bradley L. Coley), was admitted on Dec. 1, 1958, with a one-year history of pain in the right thigh and back. He dated his complaints from a fall from his bicycle in November 1957, at which time he was treated with traction. This, however, failed to alleviate his symptoms.

Physical examination revealed a scoliosis of the lumbar spine, with convexity to the left, and a localized area of tenderness to the right of L-2. No disturbances of sensation or reflexes could be discovered.

Blood chemistry determinations on admission revealed elevation of the alkaline phosphatase to 18.4 units. The calcium (11.8 mg. per cent) and inorganic phosphorus (4.3 mg. per cent) levels were normal. Six months later the alkaline phosphatase was still high (16.0 units).

Submitted films of the lumbar spine, dated Jan. 9, 1958 (Fig. 7), showed the right pedicle of L-2 to be slightly enlarged and indistinct in outline and there

Fig. 8. Case III. Expanding osteolytic lesion almost entirely destroying the right pedicle, the transverse process, and the right half of the body of L-2. Associated with this destructive process is a soft-tissue mass measuring 2.5 × 2 cm., sharply circumscribed by a calcific shell. There were what appeared to be bony strands and fine mottled radiopaque densities within this mass. Admission film.

was a suggestion of early destruction of the right side of the body of L-2.

Films taken on admission revealed an expanding osteolytic lesion almost entirely destroying the right pedicle, the transverse process, and the right half of the body of L-2 (Fig. 8). Arising laterally from the right arch of L-2 was a soft-tissue mass measuring about 2.5 × 2.0 cm., sharply circumscribed by a calcific shell. Within this mass were what appeared to be bony strands and fine mottled radiopaque densities. The lesion within the vertebra presented a faintly demarcated sclerotic border or frame. There was slight scoliosis of the lumbar spine. The roentgenologist mentioned the following diagnoses as possibilities: aneurysmal bone cyst, malignant lymphoma, and eosinophilic granuloma. Additional diagnoses of osteogenic sarcoma, Ewing's tumor, benign osteoblastoma, and an infectious process such as tuberculosis were also considered.

At operation, on Dec. 4, a mass involving the right half of the body of L-2 was found. It appeared to extend to the right transverse process and pedicle, but these portions were not adequately visualized at surgery. The enlargement of the right half of the body of L-2 appeared to be expansile in type, and was approximately 3 to 4 cm. in diameter. A reddish brown material was removed by means of curettage and a cystic shell was left in the area which had been involved by the tumor. The pathologic diagnosis was benign osteoblastoma.

In June 1959, the pain in the right side of the back and anterior part of the right thigh was still present and there seemed to be a definite increase of the scoliosis. Repeat roentgenograms did not reveal any change except for an increase of calcification in the previously described lesion. The patient was then transferred to the neurosurgical service of another hospital for re-exploration.

*Comment:* The above is an example of benign osteoblastoma occurring in one of its most common locations, the vertebral column, involving the neural arch and body of L-2. The patient was observed for more than a year, and a remarkable degree of growth of the tumor was observed. Once again, the roentgenologic appearance was that of an expanding osteolytic lesion associated with a soft-tissue mass which was sharply circumscribed by a calcific shell. Within this mass calcific deposits and fine bony strands produced a stippled pattern of increased density.

CASE IV: A. H. G., a 9-year-old boy (patient of Dr. Bradley L. Coley), was admitted on April 22, 1958, with a history of pain in the left knee for six months and a limp for three months. The pain was not relieved by aspirin. Two weeks previously the patient was admitted to another hospital, where roentgenograms revealed a lesion in the left sacrum which was biopsied and reported as "osteogenic fibroma." Histologic slides were reviewed at the time of the present admission, and a diagnosis of benign osteoblastoma was made. Physical examination was negative except for limitation of straight leg raising to about 45° on the left, and diminished left ankle jerk. Some weakness was also displayed when the patient attempted to rise up on his toes.

X-ray examination of the pelvis (Fig. 9) on the day of admission showed a clearly marginated lytic defect on the left side of the first sacral segment, measuring approximately 5 × 2 cm. Fine, irregular bony strands and radiopaque specks gave the lesion a somewhat striated and stippled appearance. There was a fracture of the involved segment with some forward slipping. The radiologist's impression was that a malignant tumor could not be definitely excluded although a benign lesion was more probable, as chondroma.

Blood chemistry determinations revealed: alkaline phosphatase, 10.2 units; inorganic phosphorus, 4.07 mg. per cent; total protein, 7.2 gm.

Exploration of the left sacrum was performed on April 28, but the surgeon was not able to reach the diseased area satisfactorily. Fragments of cortical

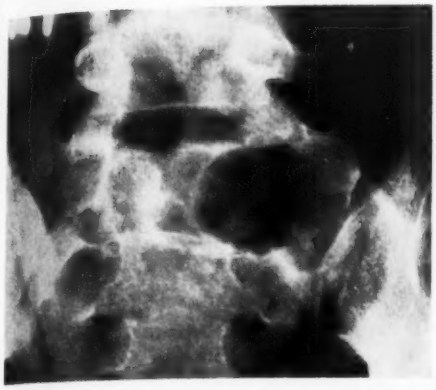


Fig. 9. Case IV. Benign osteoblastoma producing a clearly marginated lytic defect on the left side of the first sacral segment. Note fine irregular bony strands and radiopaque specks giving the lesion a somewhat striated and stippled appearance.

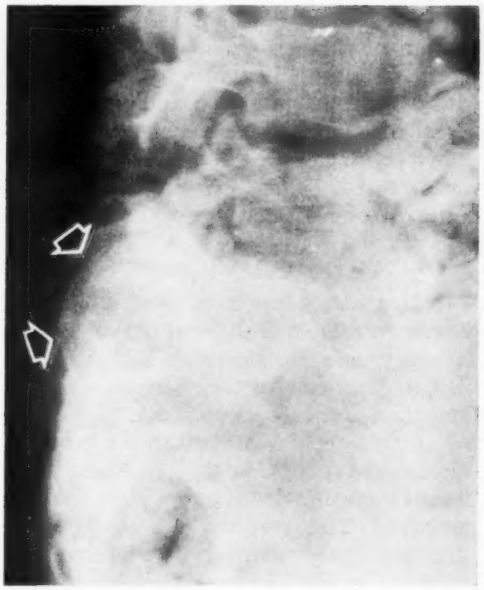


Fig. 10. Case IV. Note the characteristic soft-tissue shadow cast by the tumor, which is clearly delimited posteriorly by a calcific shell.

and cancellous bone removed at the time of operation were reported as normal bone and marrow.

Following operation there developed evidence of sacral nerve involvement, with hyperesthesia in the left saddle area and loss of rectal sphincter tone. This was associated with inability to urinate, requiring catheterization.

On Oct. 6, 1958, an x-ray study showed some increase in size of the lytic defect in the left sacrum. At that time the lateral view (Fig. 10) revealed more clearly the expansile character of the lesion and demonstrated the characteristic soft-tissue shadow cast by the tumor, with sharp delimitation by a calcific shell and increased density.

From Oct. 10 to Oct. 24 the patient received external radiation therapy from a cobalt unit, through a sacral field, for a total tumor dose of 2,650 r. He was then discharged and returned to his home town. According to the last information obtainable, December 1958, he was doing well except for a disturbance of bladder control.

*Comment:* This is another instance of tumor occurring in the vertebral column, with the roentgenologic appearance of a destructive expanding lesion. It was, however, clearly marginated and, although it had destroyed the bony cortex, it was surrounded by a calcific shell and showed a somewhat striated and stippled structure. As in the previous cases, this presents most of the features found in benign osteoblastoma.

## DISCUSSION

Experience with the 4 cases above described and a study of reproductions in other reports enables one to assert that benign osteoblastoma has a fairly characteristic radiologic appearance. This consists of a predominantly osteolytic expanding lesion with evidence of some bone formation or a varying degree of calcification. There is a tendency to erosion of the cortex and production of a soft-tissue mass which is usually well circumscribed by a calcific shell. This mass is somewhat dense because of the presence of calcific stippling. The tumor is well delimited from normal bone, does not metastasize and, as a rule, responds to conservative surgery or radiation therapy. The latter appears to have a tendency to induce extensive sclerosis or calcification within the tumor.

The neoplasm tends to grow rather rapidly and to produce local pressure effects on adjacent structures. It is more commonly encountered in the younger age group and its most frequent location is in the vertebral column, where it is prone to involve the neural arch and pedicle. In the long bones the position is equally distributed between the shaft and the ends of

the bone. Benign osteoblastoma is often seen in the smaller bones. The location is eccentric in most instances. The sclerosis with a central "nidus", which is typical in osteoid osteoma, is conspicuously absent.

In 3 of our cases the alkaline phosphatase was elevated. This may serve as an index of the osteoblastic activity of the tumor.

## DIFFERENTIAL DIAGNOSIS

Benign osteoblastomas were often misdiagnosed radiologically and pathologically as osteogenic sarcoma, chondrosarcoma, benign giant-cell tumor, benign chondroblastoma, and osteoid osteoma.

Benign osteoblastomas lack the irregular sclerosing type of bone formation, haphazard calcification, and perpendicular periosteal striations often seen in osteogenic sarcomas. Also, contrary to what happens in benign osteoblastomas, the defects produced by osteogenic sarcomas are at the ends of long bones, usually poorly defined from the normal surrounding bone, and their soft tissue extension is not limited by a calcific border. There is a tendency to recurrence and metastasis.

Chondrosarcomas are, as a rule, more heavily and more irregularly calcified than benign osteoblastomas. The calcification is characteristically disorderly. These malignant tumors are more prevalent in an older age group, often have indistinct borders, and also show a tendency to recur and metastasize. Like osteogenic sarcoma, they are rarely found in the vertebral column.

Benign giant-cell tumors of bone do not usually show the stippled, orderly calcification which is an almost constant feature of benign osteoblastoma. They are uncommon below twenty years of age, whereas more than 75 per cent of the reported cases of benign osteoblastoma were seen below this age level.

Benign chondroblastoma (7) has a fairly typical location at the epiphyseal ends of the long bones, where it often crosses the epiphyseal line. Benign osteoblastomas, when located in the long bones, do not necessarily occur at the epiphysis or have a tendency to cross the epiphyseal line, and the soft-tissue mass is usually denser, although appearances can otherwise be quite similar.

Benign osteoblastomas lack the bone sclerosis enclosing the "nidus" which is typical of osteoid osteoma, and it is difficult to understand how these two diseases could have been confused radiologically with any regularity. Furthermore, osteoid osteoma does not produce the dense soft-tissue mass which is a characteristic roentgen finding in benign osteoblastoma.

Benign osteoblastoma should also be differentiated from other benign processes, as aneurysmal bone cyst, solitary enchondromas and chondromyxoid fibroma, as well as such malignant neoplasms as fibrosarcoma of the soft tissues invading adjacent bone, metastatic bone disease, Ewing's sarcoma, and reticulum-cell sarcoma. Rarely, differentiation from an inflammatory process, such as osteomyelitis, may be necessary.

Aneurysmal bone cyst usually is easily differentiated (8) because of its ballooned-out appearance, and also because it often contains fine, incomplete septa which form loculations. When it occurs in the vertebral column, however, it may strongly resemble benign osteoblastoma. Solitary enchondromas are rare in the vertebral column, and are more frequent in limb bones, especially the phalanges and metacarpals. They do not present the rapid growth and the characteristic soft-tissue mass associated with benign osteoblastomas. Chondromyxoid fibroma is practically unknown in the vertebral column. It affects chiefly the bones of the lower limb and, although it often expands the cortex, it is not associated with a soft-tissue mass.

Fibrosarcoma of the soft tissues invading adjacent bone may bear some resemblance to benign osteoblastoma. Fibrosarcoma, however, does not present the type of bone production or calcification, which is almost always present with the latter tumor. Metastatic bone lesions tend to be multiple, whereas all the known cases of benign osteoblastoma are single.

Ewing's sarcoma (9) commonly occurs in the shaft of a long bone and presents roentgenographically as a predominantly destructive lesion which may or may not be associated with periosteal reaction. Benign osteoblastomas, on the other hand, have no predilection as to site in a long bone and more commonly exhibit roentgenologic evidence of a special type of bone production and soft-part calcification.

Reticulum-cell sarcoma (10) is another lesion which is often predominantly lytic in nature and it does not present radiologic evidence of bone production or calcification of the type seen in benign osteoblastoma. Most chordomas occur either in the sphenoccipital area or the sacrococcygeal region. Benign osteoblastoma, however, may be found at any level in the vertebral column although, to date, there have been no cases reported in the spheno-occipital region. Chordomas have a slower rate of growth and have a high tendency to recur following surgery or radiation therapy.

## SUMMARY

1. Four cases of benign osteoblastoma of bone are presented and the roentgenologic appearances of the cases from the literature are reviewed and summarized.

2. It is concluded that this rare tumor presents a fairly characteristic roentgen appearance.

3. Because of the apparent difficulty encountered in identifying this neoplasm pathologically, roentgen diagnosis assumes added importance.

4. The differential diagnosis includes a considerable number of benign and malignant bone lesions.

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## SUMMARIO IN INTERLINGUA

### Le Apparentia Roentgenographic de Osteoblastoma Benigne

Con le objectivo de determinar le characteristicas roentgenologic de osteoblastoma benigne, le litteratura esseva revistate, e 4 casos personal esseva studiate.

Le apparentia radiologic se revelava como satis characteristic. Illo es le apparentia de un expansive lesion predominantemente osteolytic con indicationes de varie grados de formation o de calcification de osso. Il existe un tendentia al erosion del cortice del osso e al production de un massa de tissu molle que es usualmente ben circumscripte per un capsula calcific. Iste massa es distinguite per un certe densitate a causa del presentia de granos de calcification. Le tumor es ben delimitate contra le osso normal. Illo non produce metastases, e usualmente illo responde a chirurgia conservatori o a radiotherapia.

Le constatationes clinic e le characteristicas roentgenologic es utile in le differentiation ab altere tumores.

Iste neoplasma tende a crescer satis rapidemente e a producer un pression local contra structuras adjacente. Su sito le plus frequente es in le columna vertebral. postea in le ossos longe.

# A General Formula for Axial Depth Dose Derived from an Empirical Power Law for Tumour-Air Ratios[1]

PAUL M. PFALZNER, M.Sc.[2]

IN A RECENT note (Pfalzner and MacDonald, 1959) it was pointed out that tumour-air ratios for cobalt-60 radiation plotted on full logarithmic paper against field area, with depth as parameter, are straight lines, *i.e.*, the following relationship appears to hold:

$$\log R(t, A_t) = \log K(t) + m(t) \log A_t \qquad (1)$$

*i.e.*,

$$R = KA_t^m \qquad (1a)$$

where $R(t, A_t)$ is the tumour-air ratio for area $A_t$, depth $t$; and $K(t)$ and $m(t)$ are constants for a given value of $t$. Using the tumour-air ratios for cobalt 60 calculated by Johns, Morrison, and Whitmore (1956), for 16 cm.$^2$ $\leq A_t \leq$ 100 cm.$^2$, the linear law (1) may be tested by calculating a correlation coefficient. Table I, column 2, gives the values of this coefficient calculated at each depth from the set of tumour-air ratios for 16, 36, 64, and 100 cm.$^2$ area. It is seen that the correlation is almost perfect, suggesting a fundamental power dependence of tumour-air ratio on field area. The Table also shows the least-square values of $K(t)$ and $m(t)$, the former decreasing steadily, the latter increasing from $t$ = 0.5 to $t$ = 18 cm, and then decreasing slightly. This change in slope appears to be real on the basis of the present data.

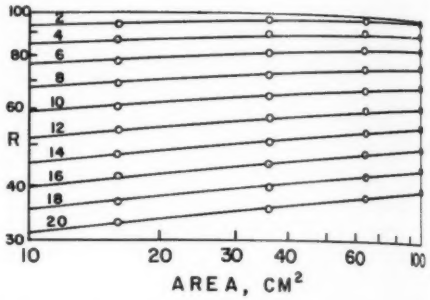



Fig. 1. Tumour-air ratios, $R$, *v.* field area for cobalt-60 on log-log paper. Circles are values given by Johns *et al.* Straight lines are drawn from calculated values of $K(t)$ and $m(t)$ as shown in Table I.

Figure 1 shows the family of curves of tumour-air ratios, and Figure 2 shows graphs of $K(t)$ and $m(t)$ against $t$.

## DERIVATION OF NEW FORMULA FOR CENTRAL AXIS DEPTH DOSE

Having demonstrated that the relation (1) is valid[3] for 16 cm.$^2$ $\leq A_t \leq$ 100 cm.$^2$, and 0.5 $\leq t \leq$ 20 cm., it is now possible to derive a relation for central axis per

TABLE I: LEAST-SQUARE PARAMETERS OF POWER LAW FOR TUMOUR-AIR RATIOS

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| $t$, cm. | $r$ correl. coeff | $m(t)$ slope | 100 $K(t)$ intercept | $m(t) - m(0.5)$ | $100K(t)/K(0.5)$ | $1 - m(t)$ |
| 0.5 | 0.990 | 0.0079 | 98.84 | 0 | 100.00 | 0.9921 |
| 2 | 0.998 | 0.0237 | 88.87 | 0.0158 | 89.91 | 0.9763 |
| 4 | 1.000 | 0.0374 | 78.10 | 0.0295 | 79.02 | 0.9626 |
| 6 | 1.000 | 0.0492 | 68.04 | 0.0413 | 68.84 | 0.9508 |
| 8 | 1.000 | 0.0613 | 58.41 | 0.0534 | 59.10 | 0.9387 |
| 10 | 1.000 | 0.0719 | 50.11 | 0.0640 | 50.70 | 0.9281 |
| 12 | 0.998 | 0.0811 | 43.07 | 0.0732 | 43.58 | 0.9189 |
| 14 | 0.997 | 0.0915 | 36.78 | 0.0836 | 37.21 | 0.9085 |
| 16 | 0.997 | 0.0983 | 31.82 | 0.0904 | 32.19 | 0.9017 |
| 18 | 0.996 | 0.1039 | 27.66 | 0.0960 | 27.99 | 0.8961 |
| 20 | 0.996 | 0.1035 | 24.64 | 0.0956 | 24.93 | 0.8965 |

[1] Presented at the Ninth International Congress of Radiology, Section V, Munich, July 1959. Accepted for publication in November 1959.

[2] Physicist, The Ontario Cancer Foundation, London Clinic (Director: Ivan H. Smith, M.D.), London, Ontario, Canada.

[3] Although the least square solutions of $K$ and $m$ were not carried beyond areas of 100 cm.$^2$, there is strong graphical evidence that the linear relation (1) holds closely up to at least 400 cm.$^2$.

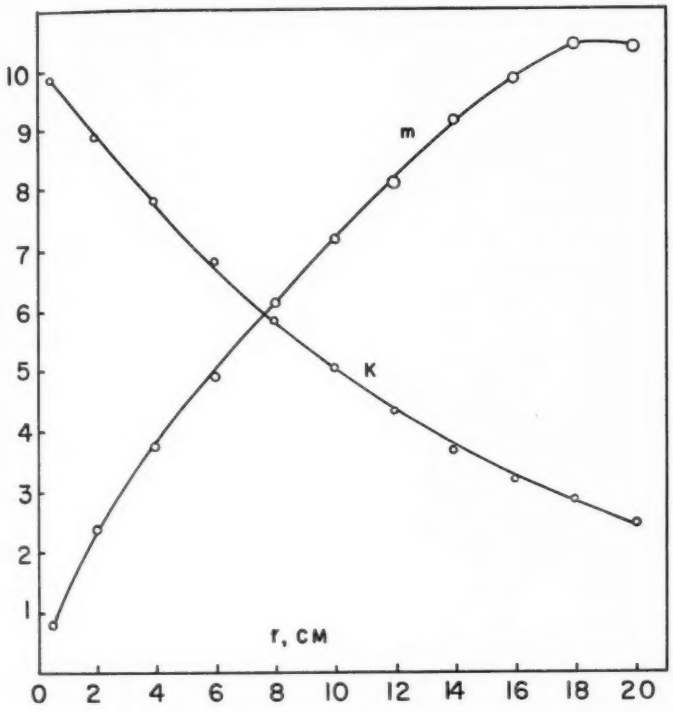



Fig. 2. Coefficients $m(t)$ and $K(t)$, (Table I) *v.* depth $t$.

cent depth dose. The definition of tumour-air ratio for cobalt-60 radiation is

$$R(t, A_t) = \left(\frac{f+t}{f+0.5}\right)^2 B(A_{0.5}) \frac{P(t, f, A_0)}{100} \quad (2)$$

where

$f$ = focus-skin distance,
$A_0, A_t$ = field areas at the surface and at depth $t$, respectively,
$B(A_{0.5})$ = back-scatter factor for surface area $A_0$ (ratio of dose at depth 0.5 cm. to dose in air at same point)
$P(t, f, A_0)$ = per cent depth dose for F.S.D. $f$, surface area $A_0$ and depth $t$,

and

$$A_t = \left(\frac{f+t}{f}\right)^2 A_0 \quad (3)$$

Substituting from (1) for $R(t, A_t)$ in (2), one obtains

$$K(t)\, A_t^{m(t)} = \left(\frac{f+t}{f+0.5}\right)^2 B(A_{0.5}) \frac{P(t, f, A_0)}{100} \quad (4)$$

If we let $t = 0.5$, then $P(0.5, f, A_0) = 100$ for all $f$ and $A_0$.
Therefore,

$$K(0.5)\, A_{0.5}^{m(0.5)} = B(A_{0.5}) \quad (5)$$

or, in general, $K(0.5)A_t^{m(0.5)} = B(A_t)$, *i.e.*, the tumour-air ratio for $t = 0.5$ is simply the back-scatter factor. Substituting for $B(A_{0.5})$ in (4), and re-arranging, we have

$$\frac{P(t, f, A_0)}{100} = \frac{K(t)}{K(0.5)} \left(\frac{f+0.5}{f+t}\right)^2 \frac{A_t^{m(t)}}{A_{0.5}^{m(0.5)}} \quad (6)$$

Now $A_t = A_{0.5}[(f+t)/(f+0.5)]^2$, and hence (6) becomes

$$\frac{P(t, f, A_0)}{100} = \frac{K(t)}{K(0.5)} \left(\frac{f+0.5}{f+t}\right)^{2-2m(t)} A_{0.5}^{m(t)-m(0.5)} \quad (7)$$

Finally $A_{0.5} = A_0[(f+0.5)/f]^2$, and one may write (7) as

$$\frac{P(t, f, A_0)}{100} = \frac{K(t)}{K(0.5)} \left(\frac{(f+0.5)^{1-m(0.5)}}{(f+t)^{1-m(t)}}\right)^2 \left(\frac{A_0}{f^2}\right)^{m(t)-m(0.5)} \quad (8)$$

This is a new formula for depth dose in terms of known coefficients $K(t)/K(0.5)$, $1 - m(t)$, and $m(t) - m(0.5)$. These are listed in Table I. It is seen that for

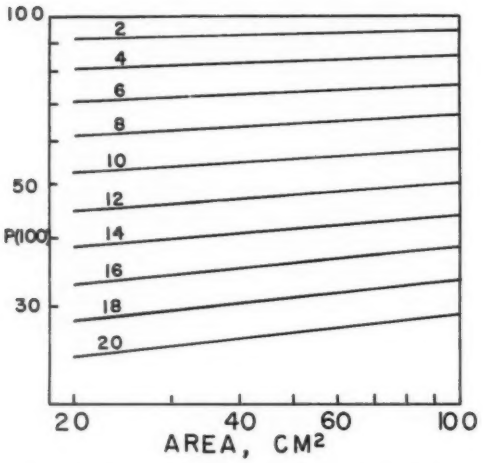



Fig. 3. Central axis per cent depth dose (from Suppl. 5, Brit. J. Radiol. 1953) for cobalt 60, F.S.D. 100 cm. *v.* surface area, on log-log paper, with depth as parameter. Straight line relation according to equation (9). This kind of plot is preferable to the more usual graphs of depth dose v. depth with area as parameter.

$t$ and $f$ constant, $P(t, f, A_0)$ is a power function of the area only, just as are the tumour-air ratios. Fig. 3 shows a plot of the family of depth dose curves for $f = 100$ cm.

One may, for easier computation, write $A_{0.5} = A_0$ in (7), resulting in

$$\frac{P(t, f, A_0)}{100} = \frac{K(t)}{K(0.5)} \left(\frac{f + 0.5}{f + t}\right)^{2-2m(t)} A_0^{m(t)-m(0.5)} \qquad (9)$$

which differs from the exact relation (8) by a factor

$$\left(\frac{f + 0.5}{f}\right)^{2m(t)-2m(0.5)} \quad \text{or} \quad \left(\frac{A_{0.5}}{A_0}\right)^{m(t)-m(0.5)}$$

whose magnitude is at most, for $f = 40$ cm., and $t = 20$ cm., equal to 1.002.

One conclusion we can draw immediately is that, in order to obtain values of the axial depth dose, one has merely to measure the tumour-air ratio at some convenient F.S.D. over a range of field areas, and calculate the coefficients $K$ and $m$. Thence it is possible to calculate the axial depth doses for any area and at any F.S.D. from relation (9) above with the same accuracy as obtained in the measurement of the tumour-air ratios.

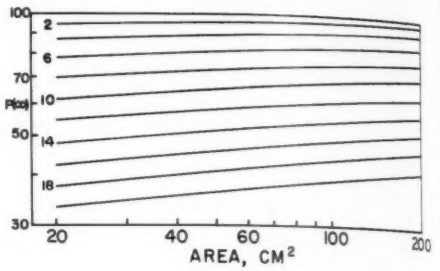



Fig. 4. $P(t, \infty, A_t)$ *v.* field area on log-log paper, with depth t as parameter (values calculated from equation (10) and shown in Table III).

As a check on the coefficients in Table I, a calculation was carried out of $P(t, f = 80$ cm., $A_0 = 100$ cm.$^2)$ using relation (9), with results as shown in Table II.

TABLE II: COMPARISON OF CALCULATED AND EXPERIMENTAL VALUES OF AXIAL DEPTH DOSE

| $t$ (cm.) | $P(t, 80, 100)$ (calc., %) | $P^*$ (exptl., %) |
|---|---|---|
| 0.5 | 100 | 100 |
| 2 | 93.3 | 93.4 |
| 4 | 83.4 | 83.4 |
| 6 | 73.4 | 73.7 |
| 8 | 63.9 | 64.2 |
| 10 | 55.4 | 55.7 |
| 12 | 47.7 | 48.2 |
| 14 | 41.2 | 41.8 |
| 16 | 35.5 | 36.2 |
| 18 | 30.6 | 31.4 |
| 20 | 26.2 | 27.3 |

NOTE: $P^*$ values taken from Brit. J. Radiol., Suppl. 5, 1953.

Agreement between calculated and experimental values is seen to be good, the differences increasing slowly with depth to 1.1 per cent at $t = 20$ cm.

An alternative expression for $P(t, f, A_0)$ may be obtained from (7) if we substitute $A_{0.5} = [(f + 0.5)/(f + t)]^2 A_t$, and let $f \to \infty$. We then obtain

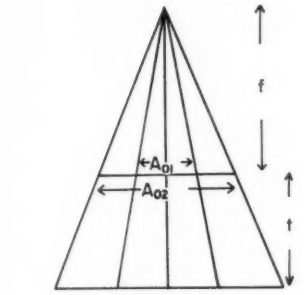
$$P(t, \infty, A_t) = 100 \frac{K(t)}{K(0.5)} A_t^{m(t)-m(0.5)} \qquad (10)$$

and hence (9) may be written

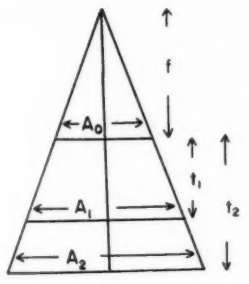
$$P(t, f, A_0) = P(t, \infty, A_t) \left(\frac{f + 0.5}{f + t}\right)^{2-2m(0.5)} \qquad (11a)$$

$$i.e., P(t, f, A_0) = P(t, \infty, A_t) \left(\frac{f + 0.5}{f + t}\right)^2 \frac{B(A_t)}{B(A_{0.5})} \qquad (11b)$$

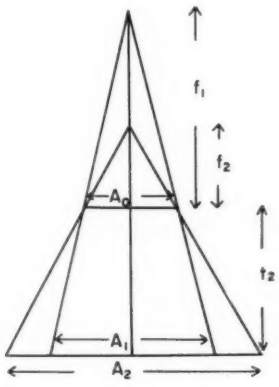
Values of $P(t, \infty, A_t)$ according to (10) have been calculated (Table III), and are




$$\frac{P(A_{01})}{P(A_{02})} = \left(\frac{A_{01}}{A_{02}}\right)^{m(t)-m(0.5)} \qquad 5$$




$$\frac{P(t_1)}{P(t_2)} = \frac{K(t_1)}{K(t_2)} \frac{A_2^{1-m(t_2)}}{A_1^{1-m(t_1)}} \qquad 6$$




$$\frac{P(f_1)}{P(f_2)} = \left(\frac{A_2}{A_1}\right)^{1-m(t)}$$

identical with

$$\frac{P(f_1)}{P(f_2)} = \frac{R(t,A_1)}{R(t,A_2)} \frac{A_2}{A_1} \quad \text{(Johns et al)}$$

and

$$\frac{P(f_1, A_0)}{P(f_2, A_0/F)} = \frac{B(A_0/F)}{B(A_0)} \cdot F$$

$$\text{where } F = \left(\frac{f_1}{f_1+t} \cdot \frac{f_2+t}{f_2}\right)^2 \quad \text{(Burns)} \qquad 7$$

Fig. 5. Conversion relation for area. The notation employed in relations (13), (14), and (15) is indicated in the geometrical drawings.
Fig. 6. Conversion relation for depth.
Fig. 7. Conversion relation for focal distance.

shown in Figure 4. They may be used to evaluate $P(t, f, A_0)$ by relation (11) for any values of $t$, $f$, and $A_0$, keeping in mind that $A_t = A_0[(f + t)/f]^2$. Using (11), one may also rewrite the tumour-air ratio (2) in the form

$$100\, R(t, A_t) = P(t, \infty, A_t)\, B(A_t) \qquad (12)$$

## CONVERSION RELATIONS

To convert from surface area $A_{01}$ to surface area $A_{02}$, for constant $f$ and $t$, one obtains from the exact relation (8) (see Fig. 5)

$$\frac{P(A_{01})}{P(A_{02})} = \left(\frac{A_{01}}{A_{02}}\right)^{m(t)-m(0.5)} \qquad (13)$$

Similarly, to convert from depth $t_1$ to depth $t_2$, for constant $A_0$ and $f$ (see Fig. 6),

$$\frac{P(t_1)}{P(t_2)} = \frac{K(t_1)\, A_2^{1-m(t_2)}}{K(t_2)\, A_1^{1-m(t_1)}} \qquad (14)$$

Finally, to convert from F.S.D. $f_1$ to F.S.D. $f_2$, for constant $t$ and $A_0$, one obtains (see Fig. 7)

$$\frac{P(f_1)}{P(f_2)} = \left(\frac{f_1 + 0.5}{f_2 + 0.5} \cdot \frac{f_2}{f_1}\right)^{2-2m(0.5)} \left(\frac{f_1}{f_2} \cdot \frac{f_2 + t}{f_1 + t}\right)^{2-2m(t)}$$

or, making the same approximation as in (9),

$$\frac{P(f_1)}{P(f_2)} \doteq \left(\frac{A_2}{A_1}\right)^{1-m(t)} \qquad (15)$$

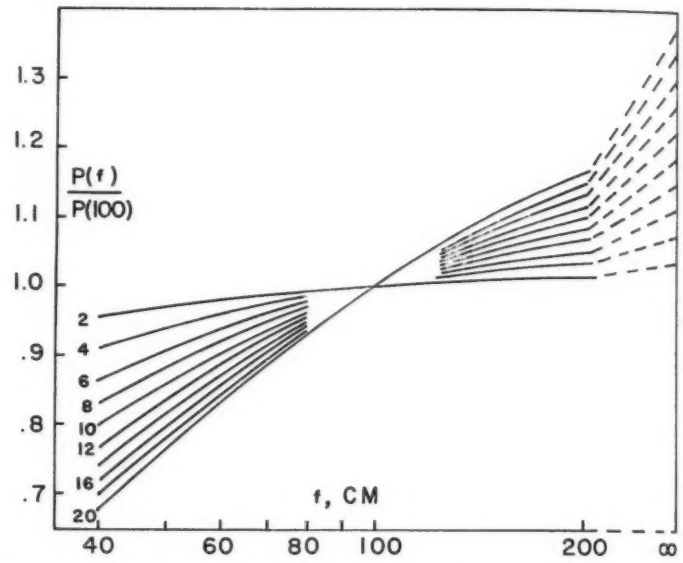



Fig. 8. $P(f)/P(100)$ *v.* F.S.D. $f$, with $t$ as parameter, calculated from (14).

TABLE III: VALUES OF AXIAL DEPTH DOSE FOR INFINITE F.S.D. AS CALCULATED FROM (10).

$$P(t, \infty, A_t) = 100[K(t)/K(0.5)]A_t^{m(t)-m(0.5)} \quad (10)$$

| $t$, cm. \ $A_t$ | 20 cm.² | 50 cm.² | 100 cm.² | | 200 cm.² |
|---|---|---|---|---|---|
| 2 | 94.27 | 95.65 | 96.70 | 96.86* | 97.76 |
| 4 | 86.30 | 88.66 | 90.48 | 90.97 | 92.34 |
| 6 | 77.90 | 80.91 | 83.23 | 83.89 | 85.70 |
| 8 | 69.34 | 72.81 | 75.53 | 76.12 | 78.42 |
| 10 | 61.40 | 65.10 | 68.14 | 68.79 | 71.18 |
| 12 | 54.26 | 58.00 | 59.62 | 61.38 | 64.19 |
| 14 | 47.78 | 51.61 | 54.66 | 55.47 | 57.94 |
| 16 | 42.20 | 45.84 | 48.80 | 49.84 | 51.99 |
| 18 | 37.31 | 40.75 | 43.55 | 44.69 | 46.55 |
| 20 | 33.18 | 36.25 | 38.72 | 39.82 | 41.36 |

* Values in column 5 were calculated from (11*a*) for comparison with (10) using tabulated values of $P(t, f = 100, A_0)$, interpolating for the appropriate $A_0 = A_t[100/(100 + t)]^2$.

In Fig. 8 the conversion factor $P(f)/P(100)$ is plotted against $f$ from 40 cm. to infinity.

## ANALOGOUS FORMULAS FOR LOWER HALF-VALUE LAYERS

It is quite feasible to demonstrate relationship (1) for other qualities of radiation (see Fig. 9) and to evaluate the respective coefficients. For x-ray qualities from 1 to 4 mm. Cu, (7) takes the form

$$\frac{P(t, f, A_0)}{100} = \frac{K(t)}{K(0)}\left(\frac{f}{f+t}\right)^{2-2m(t)} A_0^{\,m(t)-m(0)} \quad (16)$$

and, analogous to expressions (13), (14), and (15), one obtains

$$\frac{P(A_{01})}{P(A_{02})} = \left(\frac{A_{01}}{A_{02}}\right)^{m(t)-m(0)}, \quad \text{for constant } t \text{ and } f \quad (17)$$

$$\frac{P(t_1)}{P(t_2)} = \frac{K(t_1)}{K(t_2)}\frac{A_2^{1-m(t2)}}{A_1^{1-m(t1)}}, \quad \text{for constant } A_0 \text{ and } f. \quad (18)$$

$$\frac{P(f_1)}{P(f_2)} = \left(\frac{f_1}{f_2}\cdot\frac{f_2+t}{f_1+t}\right)^{2-2m(t)} = \left(\frac{A_2}{A_1}\right)^{1-m(t)}, \quad \text{for constant } A_0 \text{ and } t. \quad (19)$$

Johns, Bruce and Reid (1958) have given a relation for (19) which is

$$\frac{P(f_1)}{P(f_2)} = \frac{R(t, A_1)}{R(t, A_2)}\cdot\frac{A_2}{A_1} \quad (20)$$

and Burns (1958) derived

$$\frac{P(f_1, A_0)}{P(f_2, A_0/F)} = \frac{B(A_0/F)}{B(A_0)}\cdot F$$

where

$$F = \left(\frac{f_1}{f_2}\cdot\frac{f_2+t}{f_1+t}\right)^2 \quad (21)$$

Both of these can be shown to be equivalent to (19). The conversion relations (17) and (18), and (13) and (14), based on relations (16) and (8), respectively, have not previously been demonstrated in the literature.

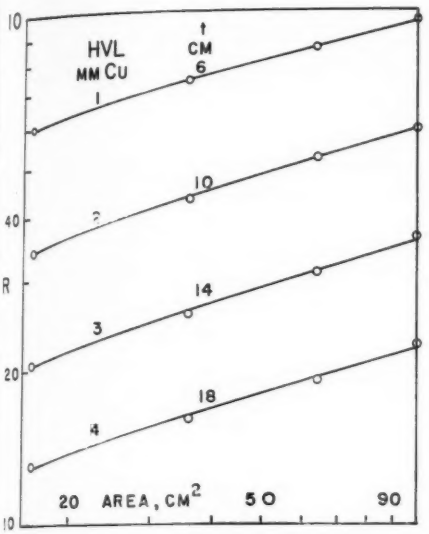



Fig. 9. Tumour-air ratios *v.* field area for h.v.l. 1, 2, 3, 4 mm. Cu on log-log paper, plotted for one depth only for each h.v.l.

## DERIVATION OF EXPONENTIAL FORM OF LAW FOR CENTRAL AXIS DEPTH DOSE

Using the results of the present analysis, it is possible also to evaluate an attenuation coefficient, $\mu$, as a function of $t$, $f$, and $A_0$, in the exponential relation for depth dose:

$$P(t, f, A_0) = 100 \left(\frac{f+0.5}{f+t}\right)^2 e^{-\mu(t-0.5)} \qquad (22)$$

Writing (9) in the equivalent form

$$P(t, f, A_0) = 100 \frac{K(t)}{K(0.5)} \left(\frac{f+0.5}{f+t}\right)^{2-2m(t)} \times e^{[m(t)-m(0.5)] \ln A_0} \qquad (23)$$

and solving for $\mu$, we obtain

$$\mu(t, f, A_0) \times (t-0.5) = -\left\{\ln \frac{K(t)}{K(0.5)} + m(t) \times \ln \left(\frac{f+t}{f+0.5}\right)^2 + [m(t) - m(0.5)] \ln A_0\right\} \qquad (24)$$

and, therefore,

$$\mu(t, \infty, A_t) \times (t-0.5) = -\left\{\ln \frac{K(t)}{K(0.5)} + [m(t) - m(0.5)] \ln A_t\right\}. \qquad (25)$$

The absorption coefficient $\mu(\infty)$ has been evaluated according to (25) for cobalt-60, using the values of $K(t)$ and $m(t)$ of Table I, and $\mu(\infty)$ $(t-0.5)$ is tabulated in Table IV for three values of area $A_t$. Figure 10 shows a semilogarithmic plot of the absorption factor $\mu(\infty)$ $(t-0.5)$ and of the attenuation factor $\mu(100)$ $(t-0.5)$ against field area with depth as parameter.

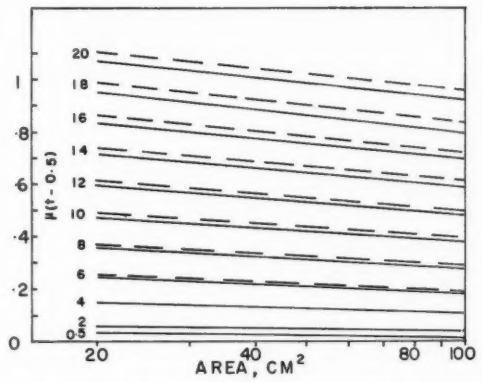



Fig. 10. $\mu(\infty) \times (t-0.5)$ and $\mu(100) \times (t-0.5)$ *v* field area on semi-log paper, calculated from (25) and (24) respectively.

TABLE IV: VALUES OF ABSORPTION FACTOR AS CALCULATED FROM (25).

| $t$, cm. | $\mu(t, \infty, A_t) \times (t-0.5)$ $A_t$ = 20 cm.² | $A_t$ = 50 cm.² | $A_t$ = 100 cm.² | $\mu(t, \infty, 1)$, cm.$^{-1}$ |
|---|---|---|---|---|
| 0.5 | 0.0300 | 0.0176 | 0.0082 | 0.0704 |
| 2 | 0.0590 | 0.0445 | 0.0335 | 0.0709 |
| 4 | 0.1473 | 0.1204 | 0.1000 | 0.0673 |
| 6 | 0.2497 | 0.2119 | 0.1833 | 0.0679 |
| 8 | 0.3662 | 0.3173 | 0.2803 | 0.0701 |
| 10 | 0.4875 | 0.4289 | 0.3845 | 0.0715 |
| 12 | 0.6116 | 0.5446 | 0.4940 | 0.0722 |
| 14 | 0.7383 | 0.6617 | 0.6038 | 0.0732 |
| 16 | 0.8626 | 0.7798 | 0.7171 | 0.0731 |
| 18 | 0.9859 | 0.8980 | 0.8314 | 0.0728 |
| 20 | 1.103 | 1.015 | 0.9492 | 0.0712 |

$\lim \mu(\infty) = -\left(\frac{d}{dt}\frac{K(t)}{K(0.5)} + \ln A_t \frac{d\,m(t)}{dt}\right)$ at $t = 0.5$ as $t \to 0.5$.

Finally, we can write (22) in the form

$$P(t, f, A_0) = P(t, \infty, A_t) \left(\frac{f+0.5}{f+t}\right)^2 e^{-[\mu(f)-\mu(\infty)]\cdot(t-0.5)} \qquad (26)$$

## DISCUSSION

The relations established in this analysis depend entirely on the validity of the power law for tumour-air ratios:

$$R(t, A_t) = K(t)\, A_t^{m(t)} \qquad (1a)$$

The correlation coefficients shown in Table I testify to an almost excessively good fit of the experimental tumour-air ratios to this law for cobalt 60. Clearly, though, this law can hold only over a limited range of values of area, since for very large areas the tumour-air ratios as well as axial depth doses will no longer increase with area, and similarly for very small areas, the tumour-air ratios and axial depth doses must approach a finite limiting value. The evidence presented here shows that the power law holds for cobalt-60 radiation from areas of 16 cm.$^2$ up to at least 400 cm.$^2$. Furthermore, the absorption coefficient $\mu(\infty)$ in (25) must approach a finite limit as the area tends to zero, namely $\mu_p$, the absorption coefficient for primary radiation ($\mu_p$ = .066 cm.$^{-1}$ for cobalt 60). In Table IV the last column gives the values of $\mu(t, \infty, A_t = 1 \text{ cm.}^2)$ and it is seen that these approximate $\mu_p$. It is, however, not possible in (25) to let $A_t \rightarrow 0$ and obtain a finite value of $\mu(t, \infty, 0)$. It remains to be seen whether the relations here established can be so modified as to represent accurately the physical data over the whole range of values of area from zero to infinity.

In addition to the above-noted limitations imposed on the power law by dependence on changes in area, these relations may exhibit a dependence on radiation quality which is not explicit in the equations here derived. In this connection, though, it is interesting to note that recently published axial depth dose values for cesium 137 do give very good straight lines when plotted against the area on full logarithmic paper. An indication that the power law (1) applies at lower half-value layers as well has been given in Figure 9, but the correlation appears not to be as high as with cobalt-60. It therefore seems likely that in order to account for changes in quality of the radiation, another term in (1) may be required which should approach unity at a radiation energy near 1 Mev.


## SUMMARY

It is shown that the tumour-air ratio, $R(t, A_t)$, is a power function of the area $A_t$, *i.e.*,

$$R(t, A_t) = K(t)\, A_t^{m(t)}$$

The coefficients $K$ and $m$ (constants for a given depth $t$) have been evaluated for cobalt-60 for $0.5 \leq t \leq 20$ cm. by the method of least squares. From the definition of tumour-air ratio in terms of per cent depth dose, it is shown that the central axis per cent depth dose, $P(t, f, A_0)$, can be expressed as a function of F.S.D. $f$, depth $t$, and surface area $A_0$, as follows:

$$P(t, f, A_0) = 100 \frac{K(t)}{K(0.5)} \left(\frac{f + 0.5}{f + t}\right)^{2[1-m(t)]} A_0^{m(t)-m(0.5)}$$

$$= P(t, \infty, A_t) \left(\frac{f + 0.5}{f + t}\right)^{2[1-m(0.5)]}$$

Useful conversion relations are derived, and analogous expressions obtained for the x-ray quality range from 1 to 4 mm. Cu h.v.l.

In addition, it is shown that an attenuation coefficient $\mu\ (t, f, A_0)$ can be evaluated in terms of the coefficients $K$ and $m$, with the result that central axis per cent depth dose may be written in the equivalent exponential form

$$P(t, f, A_0) = 100 \left(\frac{f + 0.5}{f + t}\right)^2 e^{-\mu(t, f, A_0) \times (t - 0.5)}$$

Tables and graphs are provided of factors useful for computations including $m(t)$, $K(t)$, $P(t, \infty, A_t)$, $\mu(t, \infty, A_t)$ and $P(t, f, A_0)/P(t, 100, A_0)$.

The limitations with respect to dependence on area and radiation quality of the newly derived relations are briefly discussed.


ACKNOWLEDGMENT: The author is greatly indebted to Dr. J. C. F. MacDonald of this Clinic for many useful discussions and for his interest and encouragement.

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SUMMARIO IN INTERLINGUA

**Un Formula General pro le Dose de Profundor Axial, Derivate ab Un Lege Empiric de Potentia pro le Proportion Tumor:Aere**

Es monstrate que le proportion tumor: aere, $R(t,A_1)$, es un function de potentia del area $A_t$, i.e.,

$$R(t, A_t) = K(t)A_t m(t)$$

Le coefficientes K e m, que es constantes pro un date profundor t, esseva evalutate pro cobalt$^{60}$ pro 0,5-t-20 cm per le methodo de quadratos minime. Super le base del definition del proportion tumor:aere in terminos de pro cento de dose de profundor, il es monstrate que le procentage del dose de profundor del axe central, P(t,f,Ao), pote esser exprimite como un function de F.S.D. f, profundor t, area superficial Ao, sequentemente:

$$P(t, f, A_0) = 100 \frac{K(t)}{K(0.5)} \times \left(\frac{f + 0.5}{f + t}\right)^{2[1-m(t)]} A_0^{\,m(t)-m(0.5)}$$
$$= P(t, \infty, A_t) \times \left(\frac{f + 0.5}{f + t}\right)^{2[1-m(0.5)]}$$

Utile relationes de conversion es derivate, e analoge expressiones es obtenite pro le scala de qualitate del radios X ab 1 usque ad 4 mm de Cu como spissitate de medie valor.

In plus, es monstrate que un coefficiente de attenuation, $\mu(t,f,Ao)$, pote esser evalutate in terminos del coefficientes K e m, con le resultato que le procentage de dose de axe central pote esser scribite in le equivalente forma exponential

$$P(t, f, A_0) = 100 \left(\frac{f + 0.5}{f + t}\right)^2 e^{-\mu(t, f, A_0) \times (t-0.5)}$$

Tabulas e graphicos es providite de factores que es utile pro le computationes, incluse $m(t)$, $K(t)$, $P(t,\infty,A_t)$, $\mu(t,\infty,A_t)$, $e[P(t,f,A_0)/P(t,100,A_0)]$.

Es discutite brevemente le limitationes del novemente derivate relation con respecto a lor dependentia ab area e qualitate de radiation.

# Two-Hour Uptake of Iodine 131 by the Thyroid[1]

A. RAVENTOS, M.D., JOHN HALE, Ph.D., and R. H. CHAMBERLAIN, M.D.

TESTS OF THYROID function based upon the ability of the gland to concentrate radioiodine have been carefully intercompared by several investigators (1–6). It appears that several of these uptake tests are reliable in the diagnosis of most cases of hyperthyroidism, but all tests yield equivocal results in a significant proportion of patients. In our experience, the equivocal range for twenty-four-hour thyroidal uptakes has been 40 to 59 per cent, and about 20 per cent of our patients fall into this range. We have found the forty-eight-hour protein-bound $I^{131}$ test ($PBI^{131}$) (7) a valuable supplementary aid to diagnosis in these patients.[2] With our present instrumentation, a $PBI^{131}$ test requires an administered tracer dose of about 25 microcuries, while for a thyroidal uptake determination only about 5 microcuries is needed.

It seemed undesirable to give all of our patients the larger dose required for $PBI^{131}$ tests. Conversely, it was inconvenient to wait for the twenty-four-hour thyroidal uptake to decide which patients (the equivocal group) needed a supplemental dose of $I^{131}$ for the $PBI^{131}$ determination. This study was undertaken to see if two-hour thyroidal uptakes could reliably identify the equivocal group. A comparison was made between the thyroidal uptake at two hours and that at twenty-four hours after a tracer given in liquid form to 203 consecutive patients, and both uptakes were compared with the final clinical diagnosis. Also, to extend the study to commercially prepared $I^{131}$ tracer capsules, we compared the ratio of twenty-four-hour to two-hour uptakes with a second series of 59 consecutive patients receiving such tracer capsules.

## METHOD

The tracers given in liquid form consisted of 5 to 10 microcuries of $I^{131}$ in 30 milliliters of water. Patients were instructed to fast at least two hours before and thirty minutes after the dose. The uptake in the thyroid was determined by a scintillation counter with a 1-inch diameter × 1-inch NaI(Tl) crystal collimated to a 22° angle. The counting distance was 25 centimeters. A 125-kev window was centered on the 364-kev $I^{131}$ photopeak. Approximate correction for extrathyroidal iodine in the neck at two hours was made by subtracting the count obtained over the lower thigh of the patient. The reference standard was a 20-milliliter source of $I^{131}$ at a depth of 1.2 centimeters in a 6-inch diameter × 8-inch deep water phantom. When a supplemental tracer dose was given after the two-hour count (to facilitate $PBI^{131}$ measurement), the time difference between the administration of the two doses of $I^{131}$ was neglected in calculating the twenty-four-hour uptake. Each dose was compared with the reference standard, and the $I^{131}$ remaining in the container after administration was measured and subtracted from the administered value.

For the evaluation of tracer capsules, 5 to 10 microcuries of $I^{131}$ in a gelatin capsule[3] was given to patients who fasted at least two hours before and one hour after the dose. The counting technic was the same as for the first series, except that the reference standard was an 8 × 8 × 10-inch (high) Masonite (density 0.98) phantom. The reference capsule was positioned in the center of the phantom at a depth of 1.9 centimeters. The conversion factors (counts per minute per microcurie) ob-

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[2] For example, in an independent study which will be reported in more detail elsewhere, of 134 patients with twenty-four-hour uptakes in the equivocal range of 40 to 59 per cent, 123 had unequivocal $PBI^{131}$ values and in 116 of these the $PBI^{131}$ diagnosis agreed with the final clinical diagnosis.

[3] Iodotope Diagnostic Capsules, E. R. Squibb & Sons.

TABLE I: COMPARISON OF TWO-HOUR AND TWENTY-FOUR-HOUR THYROIDAL $I^{131}$ UPTAKE IN 203 PATIENTS GIVEN LIQUID TRACER DOSES

(Diagnosis—thyrotoxic or nontoxic—is based upon clinical evaluation and all laboratory data available for each patient)

| Twenty-four-hour Uptake | | Two-Hour Uptake | | | |
|---|---|---|---|---|---|
| | | Nontoxic Range | Equivocal Range | | Toxic Range |
| | | <15% | 15–19% | 20–29% | >29% |
| Toxic Range | >59% | | | 3 toxic<br>3 nontoxic | 28 toxic<br>0 nontoxic |
| Equivocal Range | 50–59% | | | 6 toxic<br>0 nontoxic | 7 toxic<br>0 nontoxic |
| | 40–49% | 0 toxic<br>8 nontoxic | 2 toxic<br>6 nontoxic | 2 toxic<br>3 nontoxic | |
| Non-Toxic Range | <40% | 0 toxic<br>126 nontoxic | 1 toxic<br>8 nontoxic | | |

tained with the two phantoms agreed within 3 per cent. Each capsule was compared with the reference capsule.

## RESULTS AND CONCLUSIONS

Inspection of the results indicated that 15 to 29 per cent thyroidal uptake at two hours appeared to represent the equivocal range, corresponding to 40 to 59 per cent for twenty-four-hour uptakes. The data are grouped on that basis in Table I. Thirty-four patients had uptakes in the twenty-four-hour equivocal range; of these, 17 were finally classified thyrotoxic and 17 nontoxic. The number of patients in the equivocal range at two hours happened also to be 34 but, of these, 14 were toxic and 20 were nontoxic. The two-hour test successfully predicted 19 of the 34 equivocal twenty-four-hour uptakes and failed to predict 15. In all of these "failures," however, the final diagnosis made on the basis of all clinical and laboratory data agreed with the two-hour rather than the twenty-four-hour uptake. We interpret this as evidence that the two-hour uptake is a satisfactory means for identifying those patients in whom uptake studies alone may provide an equivocal result, and for whom additional studies such as a $PBI^{131}$ determination are desirable.

When the two-hour uptake test was not equivocal, it was in agreement with the final diagnosis in every case. This was not true for the twenty-four-hour test, which was in error 4 times. This is not a statistically significant difference, and we do not consider that the present study provides evidence that an unequivocal two-hour uptake is more reliable than an unequivocal twenty-four-hour uptake. It does appear, however, that the two-hour uptake is satisfactory for separating those patients who can be reliably diagnosed from uptake studies alone from those who will require additional studies such as $PBI^{131}$ determination.

The results given above are all from patients who received $I^{131}$ in liquid form. It might be expected that the average uptake of tracers given in capsules would be somewhat lower at two hours, because of the time required for the capsule to dissolve. To compare tracer capsules with tracers given in water, the average ratio of the twenty-four-hour uptake to the two-hour uptake was calculated for those patients with twenty-four-hour values between 10 and 49 per cent. Within this range, a plot of two-hour uptakes against corresponding twenty-four-hour uptakes was essentially linear. One hundred forty patients given liquid tracers had twenty-

four-hour uptakes in this range; the mean twenty-four-hour/two-hour ratio for 135 of these was 2.8, with a standard deviation of 0.06. The other 5 patients had twenty-four-hour/two-hour ratios greater than 5.0, with very low two-hour uptakes and were excluded from the calculation because it was assumed that absorption of the tracer had been abnormally slow. Food in the stomach might have caused delayed absorption, for example, as we had no assurance that patients had actually followed the instructions about fasting.

Thirty-eight of the patients given tracer capsules had twenty-four-hour uptakes between 10 and 49 per cent. Two were excluded because the twenty-four-hour/two-hour ratio exceeded 5.0. (The difference between the number of patients in the two series with abnormally low two-hour uptakes—twenty-four-hour/two-hour ratio exceeding 5—was not significant statistically—$P > 0.3$.) The mean twenty-four-hour/two-hour ratio for the remaining 36 was 3.2, with a standard deviation of 0.13.

As expected, the twenty-four-hour/two-hour ratio was higher when the tracer was given as a capsule. The difference is statistically significant at about the 2 per cent level. If the equivocal range for two-hour uptakes with tracers given in water is 15 to 29 per cent, the corresponding range with tracer capsules is 12.5 to 24 per cent. The standard deviation of single values was 25 per cent of the mean twenty-four-hour/two-hour ratio for both capsule and liquid tracers; the fact that it was the same for both suggests that the reliability of the two-hour uptake is about the same with capsules as with liquid tracers.

Based upon the above findings, we now routinely administer a tracer of about 5 microcuries, either in water or in a capsule, to most patients. If the two-hour uptake is in the equivocal range, an additional dose of about 20 microcuries is given immediately to facilitate $PBI^{131}$ measurement at forty-eight hours. Smaller doses (1 to 2 microcuries) are used in infants and children whenever possible. Patients suspected to be hypothyroid, "problem" cases in which $PBI^{131}$ studies are initially desired, and those for whom scintillation scanning is planned, are given larger initial doses. For most patients, however, the initial 5-microcurie dose is all that is needed, a preliminary diagnostic interpretation can be reported immediately following the two-hour determination, and the twenty-four-hour uptake is used for confirmation.

## SUMMARY

1. Tests of thyroid function based upon the thyroidal accumulation of $I^{131}$ give equivocal results in a significant fraction of patients, about 20 per cent in our experience. We find the $PBI^{131}$ test a useful aid to diagnosis in these patients, but it requires a larger tracer dose than is needed for thyroidal uptake measurement.

2. A comparison of two-hour and twenty-four-hour $I^{131}$ uptake studies on 203 consecutive patients indicates that the two-hour uptake equals the twenty-four-hour uptake in reliability as a screening test to identify those patients in whom thyroidal uptake information is equivocal. These patients can then be given a larger tracer dose to allow $PBI^{131}$ measurement.

3. The equivocal range for the twenty-four-hour uptake was found to be 40 to 59 per cent. The equivocal range for two-hour uptakes is 15 to 29 per cent when the tracer is given in water, or 12.5 to 24 per cent when tracer capsules are employed. The reliability of the two-hour uptake in predicting the twenty-four-hour uptake is about the same after a tracer capsule as after a liquid tracer.

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SUMMARIO IN INTERLINGUA

## Fixation Thyroide de Iodo$^{131}$ in Duo Horas

Tests del function thyroide super le base del accumulation thyroidic de $I^{131}$ produce resultatos equivoc in un proportion significative del patientes. In le experientia del autores, iste proportion amonta a circa 20 pro cento. Le test de $I^{131}$ ligate a proteina es un utile adjuta diagnostic in iste patientes, sed illo require un plus grande dose traciatori que lo que es requirite in le mesuration del fixation thyroidic.

Un studio comparative de determinationes del fixation de $I^{131}$ post duo horas e post vinti-quatro horas in 203 patientes consecutive ha indicate que le fixation post duo horas es tanto fidel como le fixation post vinti-quatro horas pro le identification del patientes in qui le information del fixation thyroidic es equivoc. Iste patientes pote alora esser tractate con plus grande doses traciatori pro permitter le mesuration del $I^{131}$ ligate a proteina.

Esseva trovate que le area equivoc in le fixation in vinti-quatro horas es le area inter 40 e 59 pro cento. Pro le fixation in duo horas le area equivcc es le area inter 15 e 29 pro cento si le traciator es administrate in aqua o inter 12,5 e 25 pro cento si capsulas es usate pro le administration del traciator. Le fidelitate del fixation in duo horas pro le prediction del fixation in vinti-quatro horas es plus o minus le mesme post administrationes del traciator in capsulas e in forma liquide.

# Roentgen Determination of the Time of Closure of the Spheno-Occipital Synchondrosis[1]

GEORGE LEIGH IRWIN, M.D.[2]

THE SPHENO-OCCIPITAL synchondrosis is the joint between the basal portions of the sphenoid and occipital bones in that portion of the skull base usually designated as the clivus. The articulation is similar to the cartilaginous junction between the epiphyses and metaphyses of long bones. A synchondrosis is a temporary union since the connecting cartilage becomes ossified with advancing age. While the times of union of epiphyses to primary centers of the skeleton have been widely studied, a paucity of information is available concerning the normal closure of the spheno-occipital synchondrosis.

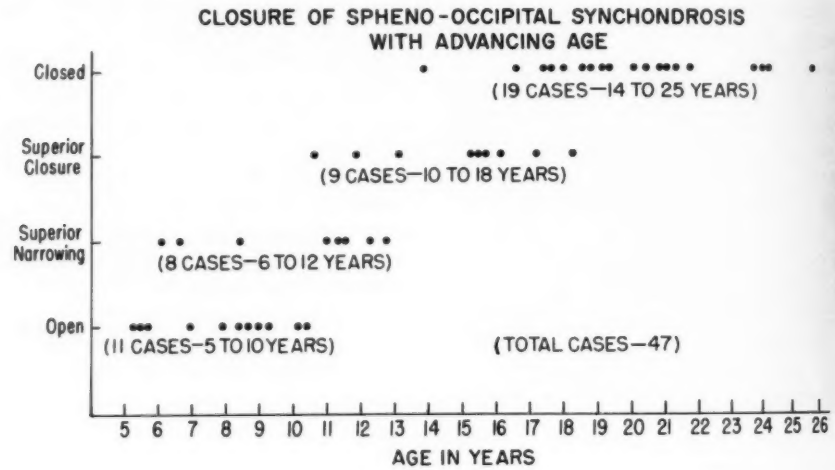
CLOSURE OF SPHENO-OCCIPITAL SYNCHONDROSIS WITH ADVANCING AGE
Closed
(19 CASES—14 TO 25 YEARS)
Superior Closure
(9 CASES—10 TO 18 YEARS)
Superior Narrowing
(8 CASES—6 TO 12 YEARS)
Open
(11 CASES—5 TO 10 YEARS)
(TOTAL CASES—47)
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
AGE IN YEARS

Figure 1

## EMBRYOLOGIC AND ANATOMIC CONSIDERATIONS

In the human embryo the earliest evidence of the cranium is found in dense masses of mesenchyme which surround the cranial end of the notochord. Cartilage formation in the developing mesenchyme in this area is apparent at the beginning of the second month of embryonic life. During the ninth and tenth weeks of embryonic life, ossification centers begin to appear in the occipital area, but most of those in the sphenoid area develop much later.

Both the occipital and sphenoid bones are of mixed intracartilaginous and intramembranous development. In both bones the intramembranous portions are more laterally situated, while the primitive skull base is entirely intracartilaginous (Henderson and Sherman; Patten). The basilar portion of the occipital bone forms from two ossification centers which coalesce early during development. The body of the sphenoid develops from four centers, two for the presphenoid and two for the postsphenoid section.

At birth the body of the sphenoid exists as a unit formed by junction of the basal

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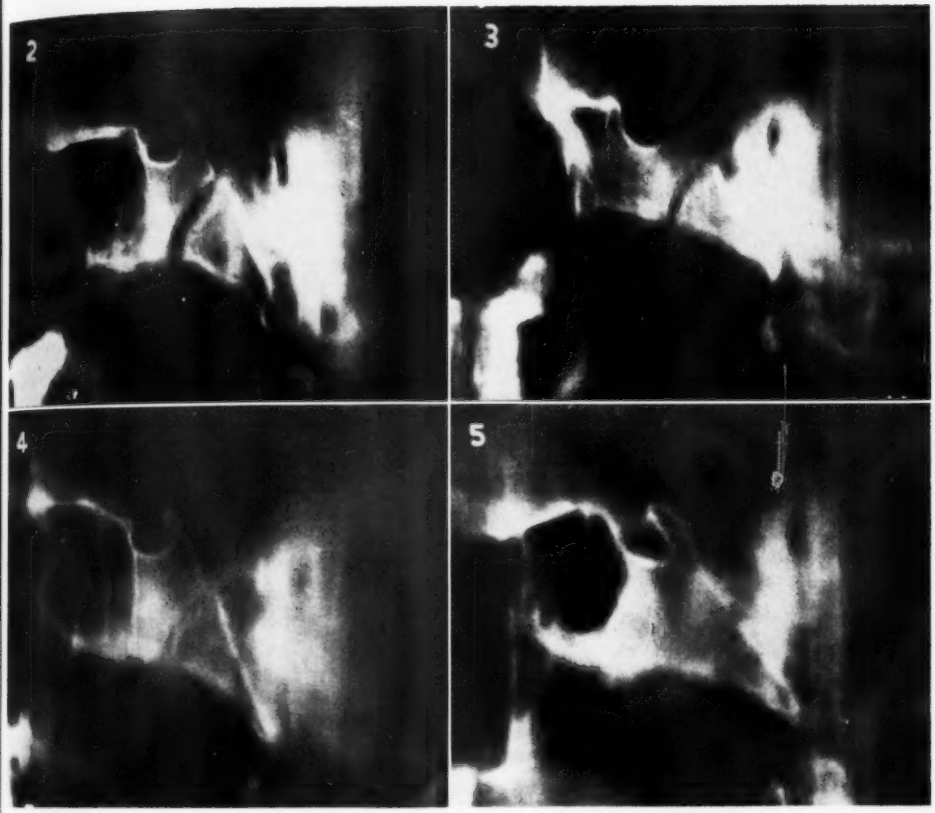


Fig. 2. Nine-year-old male with completely patent synchondrosis averaging 3 mm. in width.
Fig. 3. Seven-year-old female. Synchondrosis has begun to narrow superiorly but remains patent inferiorly.
Fig. 4. Eight-year-old male. Synchondrosis has almost closed superiorly and shows marked narrowing inferiorly.
Fig. 5. Fourteen-year-old female with synchondrosis completely closed. On the basis of this study this represents early closure of the synchondrosis.

portions of the presphenoid and post-sphenoid segments of the bone which occurs at approximately the eighth month of fetal life (Goss). The basilar part of the occipital bone is also well developed at birth. During the early years of life bone growth along the synchondrosis is even but, with growth deceleration, relative narrowing appears along the superior aspect of the articulation.

## ROENTGENOLOGIC INVESTIGATION

Prior reports indicate lack of agreement in respect to the time of closure of the spheno-occipital synchondrosis. Observations as to the time of the beginning of ossification vary from puberty (Caffey) to the third decade of life (Pendergrass, Schaeffer, and Hodes). A particularly clear description of the method of closure from above downward has been given by Goss, although he differs with others as to the age of ossification.

As a result of these discrepancies, a study was undertaken, on a limited scale, to ascertain more accurately the appearance of the spheno-occipital synchondrosis at different ages and the time of closure. The subjects for examination were chosen at random, an attempt being made to obtain at least two persons with ages corresponding to each yearly interval between five and twenty-five years of age. A total of 47 persons are included in

this report. Those with destruction or erosion about the sella turcica or with generalized abnormalities of bony development were excluded.

A single tomogram of the skull in the mid-sagittal plane was obtained in each instance, and patency of the sphenooccipital synchondrosis was evaluated on these films. Since closure of the synchondrosis occurs from above downward, the degree of patency lent itself to placement in one of the following groups:

1. Open
2. Narrowed superiorly
3. Closed superiorly, open inferiorly
4. Closed

The degree of patency of the synchondrosis according to age is graphically shown in Figure 1. The following generalizations concerning these data are made:

1. In the five to twenty-five-year age group the synchondrosis, when widely patent, generally measures 1 to 3 mm. in width (Fig. 2).
2. Closure starts above and proceeds inferiorly. This fact, described by Goss, was confirmed by this study.
3. The synchondrosis was invariably open below ten years of age, although superior narrowing was found in three patients six to nine years old (Figs. 3 and 4).
4. Superior closure was first noted at the age of eleven, and was generally present at thirteen.
5. Narrow inferior openings were noted up to eighteen years of age, after which solid closure was found. Complete fusion, however, was encountered in a single patient fourteen years old (Fig. 5).

The foregoing statements are not meant to represent a statistically conclusive study, as this is precluded by the small size of the total series and the small numbers in each age group. The observations, however, are believed to be reliable and should prove valid aids to roentgenologic interpretation.

## SUMMARY

The appearance and closure of the synchondrosis between the basisphenoid and the basilar portion of the occipital bone were studied by means of tomography in 47 persons, from five to twenty-five years of age. Closure was found to begin superiorly between ten and thirteen years of age and in general to be complete by the eighteenth year, although full fusion was present in one patient aged fourteen. Recognizable superior narrowing preceded superior closure and was encountered as early as six years of age.

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SUMMARIO IN INTERLINGUA

**Determination Roentgenographic del Tempore del Clausion del Synchondrose Spheno-Occipital**

Esseva interprendite un studio, a dimensiones restringite, visante a determinar le apparentia del synchondrose spheno-occipital a varie etates e le tempore al qual ille synchondrose es claudite. Al minus 2 subjectos pro omne anno de etate inter cinque e vinti-cinque esseva seligite al hasardo, resultante in un total de 47 subjectos. In omne caso un sol tomogramma del cranio in le plano meso-sagittal esseva obtenite, e le patentia del synchondrose spheno-occipital esseva evalutate in le resultante pelliculas.

Esseva trovate que le clausura comencia al margine superior inter dece e dece-tres annos de etate. Generalmente illo es complete al etate de dece-octo annos, sed completion del fusion esseva incontrate in un caso al etate de dece-quatro annos. Restriction superior precedeva le clausion superior e esseva trovate in certe casos al etate de solmente sex annos.

# Reflections of Disease in the Pulmonary Medulla[1]

ROBERT P. BARDEN, M.D.[2]

ALMOST FIFTEEN years ago, there appeared in RADIOLOGY a paper in which the roentgen manifestations of peripheral vascular disease in the lungs were discussed (2). In that paper, and in others dealing with the same subject which followed (3, 4, 5), it was stated that characteristic roentgen shadows in the lungs may occur in a group of disease conditions where arteriolar and capillary permeability is increased. These conditions included the so-called "hypersensitivity states" (of which periarteritis nodosa is a prime example) and toxic states such as uremia. The characteristic (but not specific) roentgen appearance of the chest was thought to be due to a reversible edema which occupied the central portion of each lung in a peculiar, symmetrical manner (7, 8) (Fig. 1). Microscopic study shed no light on the cause of this edema pattern. It was known that focal necrotic and inflammatory lesions are found in the smaller arterioles in the lung in at least 25 per cent of patients with periarteritis nodosa. Anatomical changes in vessels do not occur, however, in uremia (1).

Within the past two years, Oderr *et al.* (6) have studied the anatomy of pulmonary emphysema by microradiologic methods. These authors have shown that the lung is divided into a central zone, or medulla, and a peripheral zone, or cortex. In these two parts of the lung, the size and distribution of blood vessels differs, much as in the kidney. In the central zone or medulla there are many capillaries interposed between each pulmonary arteriole and venule, while in the cortical zone there are few (Fig. 2). Thus it would seem, according to Oderr and his associates, that "the distance of *capillary* travel for a red cell coursing through the central zone would be long in comparison

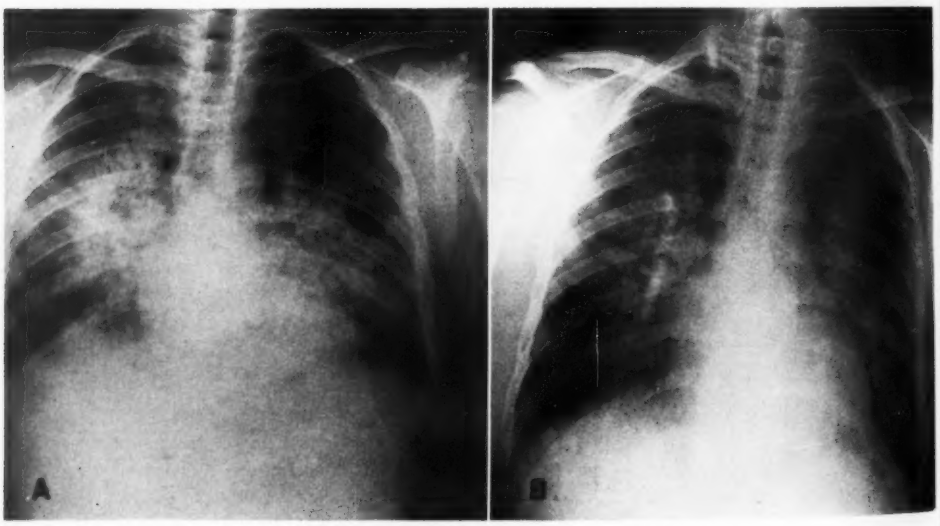


Fig. 1. Roentgenograms of a young man dying in uremia from glomerulonephritis.
A. Roentgen appearance of the chest soon after sudden onset of dyspnea and cough. Note the peculiar symmetrical shadows called "bat-wing" or "butterfly" by many authors.
B. Re-examination three days later, showing rapid disappearance of the characteristic pattern. It is evident that edema, limited to the central portion of the lungs, is subsiding.

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Fig. 2. Microradiograph of a thin cross section of lung showing normal distribution of blood vessels (not opacified). Note the large-caliber vessels which anastomose in the peripheral zone. The central zone contains fewer large vessels, but many more capillaries. (From Oderr, Pizzolato, and Ziskind: Radiology **71**: 237, 1958).

with the *capillary* travel distance in the periphery. We do not know what all the implications of this zonal anatomy may be, *but our studies would suggest that it has both physiological and pathological significance*" (italics ours).

One may now apply the knowledge gained from this significant piece of research to explain the peculiar pattern of pulmonary edema seen occasionally in periarteritis nodosa and uremia. If there are many more capillaries in the medullary portion of the lung than in the cortical portion, any condition producing increased capillary permeability will result in selective leakage of fluid in the medullary zone. One might expect the roentgen appearance to resemble that shown in Figure 1.

One might also assume in conditions such as passive congestion, where edema fluid collects in peripheral portions of the lungs and in the pleural cavities, that the mechanism of leakage is different and that vessels larger than capillaries are primarily involved.

Note: I wish to thank Drs. Oderr, Pizzolato, and Ziskind for permission to reproduce Figure 1 of their original article.

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## SUMMARIO IN INTERLINGUA

### Reflexiones de Morbo in le Medulla Pulmonar

Es signalate le characteristic sed non specific apparentia roentgenographic del thorace in certe statos de hypersensibilitate, per exemplo periarteritis nodose, e in statos toxic como per exemplo in uremia. Isto esseva interpretate como le effecto de un reversibile edema que occupava le portion central del pulmones in un maniera peculiarmente symmetric. Recente studios monstrate que le pulmon consiste de duo partes, un cortice e un zona central o medulla que es ric in capillares. Omne condition que resulta in un augmento del permeabilitate capillar effectua per consequente un escappamento selective de liquido a in le zona medullar.

# Teratoma of the Neck Causing Neonatal Death

## A Case Report[1]

IVAN M. WOOLLEY, M.D., and HOMER H. HARRIS, M.D.

ACCORDING TO statistical reports, teratoma of the neck is a rare entity. The following case is therefore considered to be worth recording.

A 17-year-old primipara was referred to the Department of Radiology in the thirty-sixth week of pregnancy. Between the thirty-sixth and the thirty-seventh week her external uterine measurements increased from 33 to 43 cm. Only one fetal heart tone was audible.

A fetogram demonstrated a fetus *in utero* with skeletal development compatible with the history of pregnancy. The fetal head was caudad and appeared to be in extended position. The fetal spine was also extended, and the extremities were peripherally placed in relation to the body. There was definite evidence of polyhydramnios.

The radiographic impression was polyhydramnios with probable soft-tissue pathology, most likely involving the abdominal viscera, as the cause of the extended attitude of the fetus.

One week later there developed constant abdominal distress, with irregular contractions of the uterus which persisted for twenty-four hours. A recheck fetogram at that time showed no change in the attitude of the fetus. The patient was taken to the delivery room and the membranes were ruptured. A measured 5 liters of amniotic fluid was obtained in fifteen minutes. Active labor ensued and complete dilatation was obtained in approximately ten hours. A right occiput posterior position was corrected without difficulty, but no further advancement of the head occurred. The fetal heart tones continued to be strong and regular. It became evident that there was a midpelvic arrest and section was considered advisable.

A male infant weighing 2,850 grams was delivered but died immediately from anoxia due to laryngotracheal obstruction. A large cystic mass involved the entire anterior aspect of the neck from the mandible downward and projected over the anterior chest wall to the level of the nipples. A rather firm nodular structure could be felt in the left side of the mass. No other defects were visible.

A radiograph revealed considerable calcific material in the left side of the tumor. This did not resemble any recognizable anatomical structure. There was no evidence of air in the lungs or in the gastrointestinal tract and no skeletal abnormalities were demonstrated.

Fig. 1. Fetogram showing the extended spine, the peripheral displacement of the extremities, and evidence of polyhydramnios.

The pathologist's report is as follows: "The cervical mass weighs 483 grams, with dimensions of 12 × 10 × 9 cm. It is attached firmly to the anterior aspect of the larynx and trachea and does not extend into the mediastinum; it is separate from the thymus gland. There is appreciable edema of the larynx and sufficient distortion of the cervical portion of the respiratory tract to cause respiratory obstruction. Although there are embryonal tissues in this neoplastic mass, cells having the cytologic criteria of carcinoma are not recognized. The components include epithelium morphologically, salivary gland, brain and central nervous system tissue, cartilage, bone, and skin, including hair and sebaceous glands.

The blocks taken from the "region of the larynx reveal a residual of thyroid tissue in the margin of the neoplasm, suggesting that the tumor may have arisen without this gland."

Since this case report was prepared,

[1] From the Department of Radiology of the Emanuel Hospital, Portland, Ore. (I. M. W., Department of Radiology; H. H. H., Department of Pathology). Accepted for publication in December 1959.

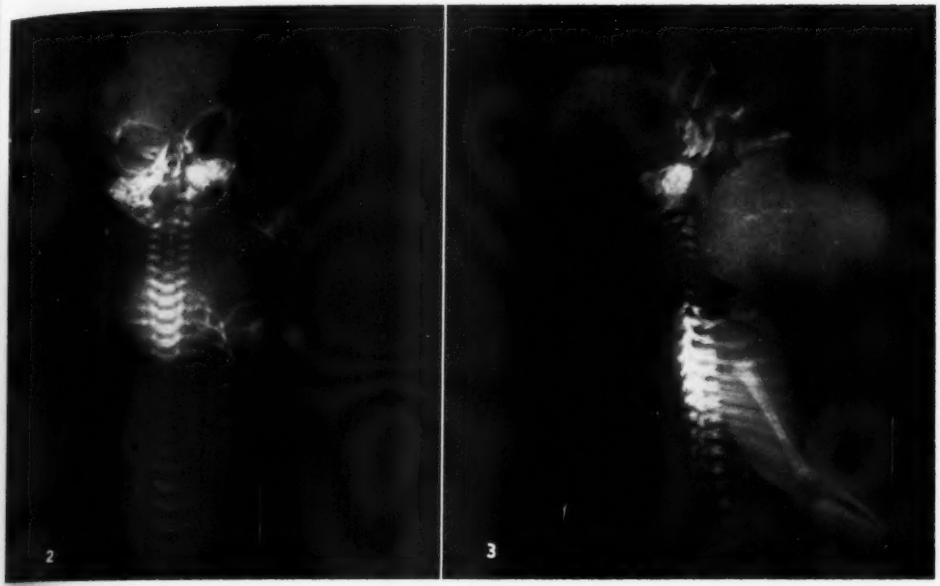

Fig. 2. Anteroposterior projection demonstrating the size of the tumor and the occlusion of the trachea. The presence of calcific material within the tumor is well shown.
Fig. 3. Lateral projection, showing obliteration of trachea.

we are informed that teratoma of the neck was discovered in an infant one year of age at another Portland hospital. The tumor was small and had been present since birth. It was successfully removed by surgery. That case, together with the one presented above, is to be reported elsewhere by the pathologists.

Emanuel Hospital
Portland 12, Ore.

SUMMARIO IN INTERLINGUA

## Teratoma del Collo, Como Causa de Morte Neonatal

Teratoma del collo pare esser un entitate rar. Es reportate un caso in un feto mascule, causante arresto mesopelvic e necessitante un section cesaree. Morte ab anoxia causate per obstruction laryngotracheal occurreva immediatemente post le parturition. Le integre aspecto anterior del collo esseva involvite in un grande massa cystic, con extension in basso ab le mandibulas usque al nivello del mammillas. Le componentes del massa esseva tissu de cerebro e systema nervose central, cartilagine, osso, pelle, capillo, e glandulas sebacee.

# An Adjustable Shielding Device for Use in Diagnostic Roentgenology[1]

BERNARD S. EPSTEIN, M.D.

THE PREVENTION of gonadal x-ray exposure, particularly in children and adults in the childbearing age, has been stressed as of primary importance. Even though it is not completely certain what damage may occur at specific dosages either to the individual or his progeny, a simple method of effectively preventing such irradiation during diagnostic procedures is highly desirable. This has been achieved with varying degrees of difficulty and accuracy by means of shields placed over the gonadal areas. Such devices, however, have the disadvantage of being rather cumbersome, they are large enough in some instances to obscure important areas, and are objectionable to some patients because they are placed directly on the pelvic areas.

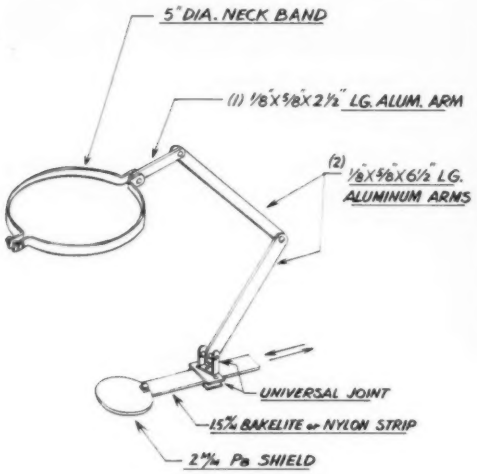


Fig. 1. Line drawing of x-ray shielding device.

During the past months we have devised a simple apparatus for accurate focusing of the area to be protected from x-ray exposure, which is moved in and out of the field with ease, blocks x-rays effectively, and requires no body application. An aluminum ring is clamped around the neck of a collimating cone containing a light source for illuminating the field to be exposed to x-rays, such as the Videx cone in use in our department. Attached to this are three angled arms made from thin aluminum strips, as shown in the accompanying illustrations, permitting the introduction into and removal from the radiographic field of a lead disk 2 mm. in thickness, mounted on a sliding arm. The range of movement is augmented by a universal joint with a slot arrange-

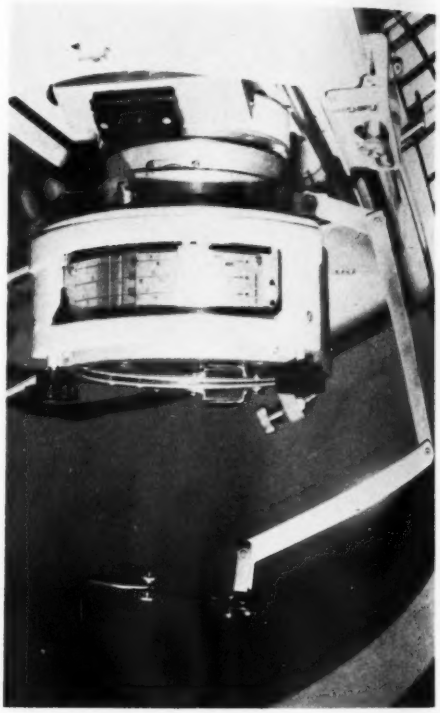

Fig. 2. Shielding device mounted on Videx Palmer Collimator, Model 3.

[1] From the Department of Radiology, The Long Island Jewish Hospital, New Hyde Park, N. Y. Accepted for publication in December 1959.

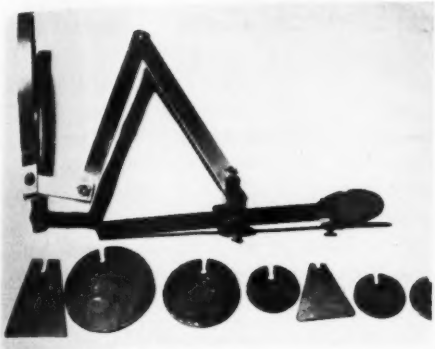

Fig. 3. Dismounted shielding device, with variety of lead shields.

ment which allows movement of the thin Bakelite strip upon which the disk is mounted. The size of the shielded area can be varied by changing the distance from the x-ray source so that the shadow is either enlarged or diminished in size. Disks of various shapes and sizes can be inserted for additional patterns.

The apparatus weighs but a few ounces and does not interfere with the counterbalancing of the tube carrier. In practice, the patient is placed on the table, the field is illuminated with the lighting device, and the disk is moved into the field to cover the desired area.

Readings made with Victoreen dosimeters, Model 541 A, have consistently shown, with exposures resulting in a dosage of 200 milliroentgens measured in air at the table top outside the protected field, only 6 to 8 milliroentgens under the disk shadow. The cut-off at the edges of the shielded region is quite clean, as evidenced on the sample abdominal film reproduced here.

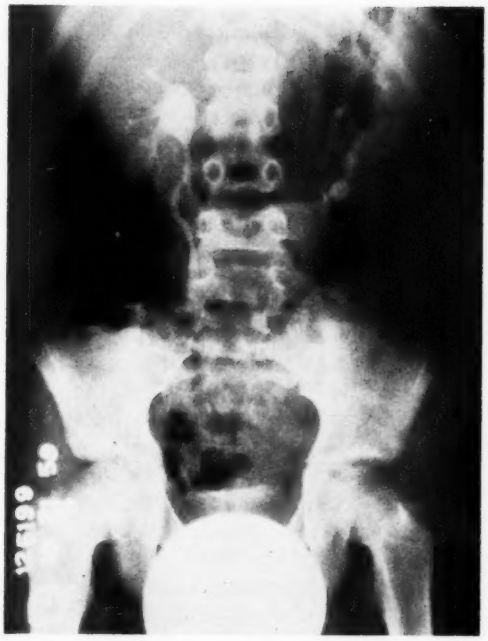

Fig. 4. Intravenous urogram with gonad area blocked by round shield shadow.

NOTE: I would like to thank Mr. Leonard Peyser of the Howdon Videx Products Corp. for help in fabricating this device.

270-05 76th Ave.
New Hyde Park, N. Y.

SUMMARIO IN INTERLINGUA

**Un Adjustabile Dispositivo de Protection pro le Uso in Radiologia Diagnostic**

Es describite un simple dispositivo de protection pro le uso in labores de radiologia diagnostic. Un anulo de aluminium es crampate circum le collo de un cono de collimation continente le fonte de lumine pro le illumination del campo a examinar. Es attachate a iste anulo tres bracios angulate que permitte le introduction a in le campo radiographic e le retiration ab illo de un disco de plumbo de 2 mm de spissitate que es montate super un bracio glissante. Le dimensiones del protegite area pote esser variate per alterar le distantia ab le fonte de radios X o per le uso de discos de differente conformationes e dimensiones.

Con expositiones de 200 milliroentgens al capite del tabula (in aere), le dosage del protegite area es uniformemente non plus que 6 a 8 milliroentgens.

# Medicine's Role in Prepaid Medical Care Plans[1]

LEONARD W. LARSON, M.D.[2]

I AM DELIGHTED to have this opportunity to consider the subject of "medicine's role in prepaid medical care plans." Furthermore, I feel right at home among radiologists because, as a pathologist, I have had to concern myself at times with some of the problems peculiar to our specialties, and we may perhaps have to cope with these issues again before they are resolved satisfactorily.

Putting aside what we—radiologists and pathologists—have gone through over the past few years, I would like to review what *has* been accomplished in the field of medical care, what *is now* being done, what *must* be done in the future.

Living and practicing in these difficult, changing times, we no longer can confine ourselves to the enormous task of trying to be good doctors and keeping abreast of scientific advances. We also must devote some of our attention to the many social, economic, and political issues which involve medicine. This is imperative because the way in which they are solved will have a vital effect on the practice of medicine, the quality and cost of health care, and the overall socio-economic climate of American life.

One of our major problems today is the relationship between medicine and the third parties, of various types, involved in the organization, provision, and financing of medical services. This problem involves our relationship with all kinds of groups which sponsor or operate health insurance and prepayment plans—labor unions, industries, consumer groups, insurance companies, Blue Shield, Blue Cross, and many others.

In the past, one of our major difficulties has been the lack of a clear, definitive policy in this area. This has been especially confusing with respect to the principle of *freedom of choice of physician*, and the question of whether or not physicians should participate in so-called *closed panel plans*.

To help arrive at a sound policy, the Board of Trustees of the American Medical Association, in December 1954, appointed the Commission on Medical Care Plans. After more than three and a half years of exhaustive study, that Commission presented its final report at the A.M.A. Clinical Meeting in Minneapolis last December. Final action was postponed until the Annual Meeting this past June (1959) in Atlantic City, so that the entire profession would have ample time to study the report and formulate opinions. Now, as a result of the A.M.A. House of Delegates' action in June, we do have a policy on the complex subject of third parties. Contrary to some reports and interpretations, the Atlantic City action did not mark a *change* in A.M.A. policy. Instead, we should view it as the establishment, for the *first time*, of a broad policy, which naturally will be subject to continual study, clarification, refinement, and revision in the years ahead.

Many of you may have read Part I of the Commission report, which contained findings, conclusions, and recommendations. I should emphasize that the A.M.A. House of Delegates received all findings and conclusions as "information only." In other words, statements in those parts of the report cannot be cited out of context as official A.M.A. policy. The House *did*, however, take definite action on the Commission's *thirty-nine* recommendations. It accepted *thirty-six* of them without change, and it reworded three others involving miscellaneous and unclassified plans.

Space will not permit a detailed report

[1] Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

[2] Chairman of the Board of Trustees, American Medical Association.

here on the new A.M.A. policy. However, as briefly as possible, I should like to point out a few important highlights. The most significant action came on the much discussed Recommendation B-16, which was changed to read as follows:

"The American Medical Association believes that free choice of physician is the right of every individual and one which he should be free to exercise as he chooses. Each individual should be accorded the privilege to select and change his physician at will or *to select his preferred system of medical care*, and the American Medical Association vigorously supports the right of the individual to choose between these alternatives."

That statement, as I interpret it, reaffirms our fundamental faith in the principle of freedom of choice, but it also recognizes the patient's right to choose the *type* of medical care plan he wants, including a closed panel plan. By implication at least, it also says that it is not unethical for a physician to participate in a so-called closed panel plan.

The A.M.A. House of Delegates also strongly endorsed Recommendation B-11, which declares that those who receive medical care benefits as a result of collective bargaining should have the widest possible choice from among medical care plans for the provision of such care.

In connection with freedom of choice, the House also urged all constituent medical associations to consider the "far-reaching significance" of Recommendation A-7 which says:

"'Free choice of physician' is an important factor in the provision of good medical care. In order that the principle of 'free choice of physician' be maintained and be fully implemented, the medical profession should discharge more vigorously its self-imposed responsibility for assuring the competency of physicians' services and their provision at a cost which people can afford."

In other words, if we are to give full meaning and value to the principle of freedom of choice, we must establish effective mechanisms to discipline that *small* minority of physicians whose actions bring discredit to the entire profession.

As I see it, from the long-range point of view, some of the most important Commission recommendations are those which call upon the American Medical Association and the state and county medical societies to increase their efforts in certain fields of activity. These include continuing review and study, closer attention to legal and legislative factors, elimination of abuses, creation of new mechanisms to meet demonstrated needs, sponsorship of national and regional conferences, and development of guides for the relationships between medicine and the various types of third parties. To help accelerate developments in those areas, the A.M.A. Division of Socio-Economic Activities is now studying ways to implement a seven-point program approved by the House of Delegates for immediate attention.

The aid of radiologists in initiating programs which will bring about better understanding and closer liaison between physicians and all types of prepaid medical care plans is greatly to be desired. Full support of the A.M.A. policy, in my opinion, will help prove the superiority of private methods in the fields of health care and health insurance. Medicine and all third parties trying to do a sound, ethical job under our private enterprise system should strive to become allies in the fight against a common danger—government encroachment which would lead insidiously to government control over our entire system of health care. The most imminent threat in that direction lies in the field of health care for the aged. Right now there is a bill in Congress—the Forand Bill[2]—that would amend the Social Security Act to provide for the Federal purchase of certain health care services for eligible beneficiaries. Were this measure to become law, some 16 million persons, all eligible for Social Security benefits, would be affected. These millions of people fall into four groups:

1. Retired workers and their depend-

[2] Since this paper was presented, the Forand Bill has been rejected by the House Ways and Means Committee. However, several bills, which are similar to the Forand Bill in that they provide health care benefits through the social security system, have been introduced in the Senate.

ents (men over sixty-five, women over sixty-two).

2. Those still working beyond retirement age.

3. The dependents of those who have died either before or after retirement.

4. Persons receiving disability benefits and their dependents.

All of these would be entitled to receive hospital, surgical, and nursing home treatment under a government-run program, with the government contracting to pay hospitals, nursing homes, physicians, and dentists for the services they would provide. This bill would thus add millions of persons to the total already eligible for some sort of medical or hospital care from the Federal Government. And the latest figures I have show that almost one-fifth of the United States population is eligible for such benefits.

Even without legislation of this type, there already are some thirty different medical programs operated by twenty-two separate agencies and departments of the federal government. The total federal budget for health and medical activities has been increasing constantly over the past thirty years, and at an especially rapid rate during the past ten or fifteen years. In the 1959 fiscal year it reached $2,800,000,000.

The thirty-one million Americans who can turn to the Federal Government for some or all of their medical care include almost twenty-three million veterans, three and a half million servicemen's dependents, three million active-duty and retired personnel of the uniformed services, more than two million federal employes, and others in miscellaneous categories. And each session of Congress brings a flood of new proposals which, in a variety of ways, would increase federal spending on health programs, or would add to the number and proportion of people receiving health care provided or financed by the Federal Government.

The fact that certain legislators and, I suspect, millions of people believe that by the simple expedient of taxation they can dump upon the government all the complex problems of health, disease, old age, and disability, is an indication to me that they are seeking an escape from personal, family, and community responsibilities. Mr. Average Citizen is being lulled into complacency by theories of easy payroll deductions through taxation and by promises to relieve him of the burden of thinking and acting upon the health needs faced by himself, his family, and his community. We are told that if we pay enough taxes the government will do the job for us. So we pay and pay—paying for the privilege of deluding ourselves that we are fulfilling our responsibilities. Well, we are being fooled. There are no easy answers, no pat solutions for health and medical needs.

The proponents of the Forand Bill would have us believe otherwise, for they say that a small increase in the Social Security tax would pay the bill for the services offered in the proposed legislation. But I say that the expense would be staggering. The costs during the first two years have been conservatively estimated at two billion dollars. Other estimates run as high as two billion for the first year alone. There is, of course, really no way of predicting the cost in the years ahead. Federal programs expand; they never contract.

Furthermore, if enacted, the bill would provide that the Federal Government control disbursement of funds; determine the benefits to be provided; set the rates of compensation for hospitals, nursing homes, dentists, and physicians; audit and control the records of hospitals, nursing homes, and patients, and promulgate and enforce standards of hospital and medical care. Legislation of this type is political medicine, and bad medicine. It would be medical care on a production-line basis. It would mean standardization of treatment and care of patients instead of the flexibility of medical technics so essential to the personal treatment of patients. Another consequence would be the overuse and overcrowding of our

hospital facilities. A substantial increase in hospital use would result immediately.

Physicians are not opposed to hospital care, but we believe that patients should be placed in hospitals, nursing homes, and other institutions only when necessary. In our opinion, the length of stay, as well as the treatment provided, should be dependent upon the patient's condition, and not upon limitations of legislation or regulations.

And here are some further bad effects of legislation of the Forand type that I believe all physicians should know:

It would reduce drastically the community incentive to support hospitals.

It would discourage the freedom to experiment at the local level with such new programs as home care, day hospital service, homemaker services, progressive patient care, and new concepts for treatment through outpatient departments and doctors' offices.

It would discourage families from taking care of their own.

The close personal and professional relationship between the doctor and patient would be severely handicapped. And, as physicians, we know that this above all things is the basis of all effective health care.

It would lead eventually to compulsory health insurance for everyone. This kind of legislation, as anyone who has watched Federal health programs knows, is merely the foot-in-the-door. Once passed, the program would be extended and extended—probably every Federal election year. This continuing trend would first undermine and eventually destroy our system of voluntary health insurance and the private practice of medicine.

In my opinion, medicine has two objectives: To defeat legislation of the Forand-type by establishing and maintaining a united front of physicians, hospitals, insurance companies, Blue Cross, Blue Shield, and all other groups that would be affected by such legislation either immediately or in the long run. Second, we must show that medicine and its allies have a better answer than the kind offered by such legislation.

Our objective then is not only to defeat an undesirable bill in Congress. Our real goal is to help solve the needs of our senior citizens. And the health needs of the aged give us an opportunity for practical action—a challenge to produce dramatic progress in the growth and development of health insurance coverage for older people. Already more than 43 per cent of the people over sixty-five who need and want coverage have some form of health insurance protection. And I might add that the number of persons over sixty-five covered by voluntary health insurance has been increasing at a greater rate than the total number of persons reaching that age. Furthermore, American medicine will continue to investigate new ways of helping our senior citizens help themselves. And we will activate and promote these new approaches for the benefit of the aging and the aged.

So I urge each of you to give full, enthusiastic support to all medicine's efforts in the field of the aging. Do not wait for the other fellow to become active. Start today. What you do now will be of untold benefit to a most important segment of our society—the elderly—and to our profession, this nation's private enterprise system, and our society as a whole.

535 North Dearborn St.
Chicago 10, Ill.

SUMMARIO IN INTERLINGUA

**Le Rolo del Medicina in Programmas de Prepagamento pro Attention Medical**

Un del major problemas con que le profession medical se trova confrontate in nostre dies es le relation con "tertios" le quales—como le companias de assecurantia, le organisation del "Blue Cross" e del "Blue Shield," etc.—participa in le organisation, le provision, e le financiation de servicios medical. Le politica del

Association Medical American (que es recommendate como digne de supporto) sublinea le derecto del individuo de seliger su medico e le typo de programma de attention medical desirate.

Un invasion per le governamento, que resultarea insidiosemente in le regulation governamental del integre systema de assistentia medical, es un menacia imminente, particularmente in tanto que il se tracta del provision de assistentia sanitari pro vetulos. Le periculos inherente in le bill de Forand—rejicite per le Commission del Budget in le Camera del Representantes post le presentation de iste adresse—e altere proponimentos de legislation del mesme genere es discutite.

In iste connexion le profession medical ha duo objectivos: Vincer omne legislation de iste typo e demonstrar que le medicina e su amicos cognosce un melior solution del problema del assistentia medical.

# Visualization of the Spleen in Man by Radioisotope Scanning[1]

JAMES W. WINKELMAN, M.D., HENRY N. WAGNER, JR., M.D., JOHN G. McAFEE, M.D., JAMES M. MOZLEY, Ph.D.

To visualize an organ by scintillation scanning, a gamma-emitting radioisotope must reach a considerably higher concentration within the organ than in the surrounding tissues. A method for scanning the spleen has recently been reported (2). $Cr^{51}$-labeled $Rh_0(D)$ positive red blood cells, "sensitized" for splenic trapping by coating with incomplete anti-$Rh_0(D)$ antibody, were administered intravenously to $Rh_0(D)$ positive persons. This method, however, could not be used in Rh negative patients and necessitated typing of each patient's blood.

On the basis of the observation that heated red blood cells concentrate in the spleen (1), a simple technic which gave a good spatial image of the spleen was developed. Ten cubic centimeters of the patient's blood were withdrawn into a sterile syringe containing 2 c.c. of ACD anticoagulant. Two hundred microcuries of $Cr^{51}$ sodium chromate were added. After incubation at room temperature for fifteen minutes, 50 mg. of ascorbic acid were added to reduce residual chromate to chromic ions. The tube was then incubated in a water bath at 49.5°C. ± 1° for one hour. After cooling, the blood was administered intravenously. Heating of the red blood cells increased osmotic fragility but did not cause hemolysis. By phase microscopy, the heated red cells exhibited poikilocytosis, anisocytosis, and pseudopodial bulges from the surface.

Fig. 2. Scintiscan of normal spleen superimposed on routine abdominal film.

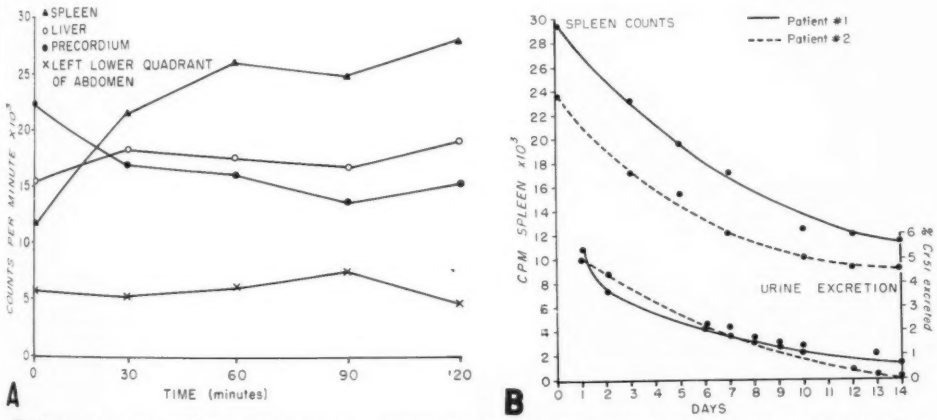


Fig. 1. A. In vivo counting over spleen, liver, precordium, and left lower quadrant after intravenous administration of $Cr^{51}$-labeled heated red cells. Mean values of 17 patients.
B. Disappearance of splenic radioactivity and urinary excretion of $Cr^{51}$ in two normal subjects.

*In vivo* counting following injection revealed maximum concentration of the altered red blood cells in the spleen between one and two hours (Fig. 1,A). Scintillation scanning was then performed with the patient supine. A 3 × 3-inch sodium iodide crystal, 12-hole focusing collimator, and scintillation spectrometer were used. The scanning image was produced by a high-contrast photorecorder on regular x-ray film. A routine abdominal radiograph was obtained on the scanning stretcher for accurate localization of the scanning image.

In each of 17 subjects, the technic produced a clearly delineated image of the spleen (Fig. 2). The

ratio of the counting rate in the splenic area to that of the surrounding tissues averaged five to one. Enlargements and displacements of the spleen were demonstrated. In the future, the procedure should prove valuable in the differential diagnosis of obscure abdominal masses, in the clinical assessment of splenomegaly, and in the detection of splenic infarcts, abscesses, and cysts, and of accessory spleens.

The effective half-time of the radioactivity in the splenic area was approximately eight days as determined by serial *in vivo* counting (Fig. 1,B). Within this interval, about 25 per cent of the administered radiochromium was excreted in the urine. The total dose of radiation delivered to the spleen was calculated to be 4 rads, and the total-body irradiation less than 0.05 rads. The procedure, therefore, was within reasonable limits of radiation dosage.

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2. JOHNSON, P. M., HERION, J. C., AND MOORING, S. L.: Scintillation Scanning of the Normal Human Spleen Utilizing Sensitized Radioactive Erythrocytes. Radiology **74:** 99–101, January 1960.

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[1] From The Diagnostic Radioisotope Laboratory, The Johns Hopkins Hospital, Baltimore, Md. This work was supported by U.S. Public Health Service Research Grant #A-3128.

# EDITORIAL

## Forty-Sixth Annual Meeting
## The Radiological Society of North America

The Radiological Society of North America, Inc., will convene in its Forty-Sixth Annual Meeting at the Netherland-Hilton Hotel, Cincinnati, Ohio, from December 4 to 9, 1960. This "call to the meeting" is issued on a saddened note because of the passing of Donald S. Childs, Sr., M.D. His absence will be felt keenly by all of the members and officers who have relied upon him so greatly during the twenty-nine years of his secretaryship of this Society. As if to counteract this great loss, the members of the Society, the Society office staff, the hotel executives, the manufacturers of radiological equipment and supplies, the independent contractors who move this great show into and out of the hotel, and many others, have offered extraordinary help to the officers of the Society who are charged with the success of the meeting.

The response to the request for scientific papers was so great that it was with difficulty that the Program Committee reduced the amount of material to the time and space available for its presentation. At this time, I should like again to express my regrets to those whose essays could not be included. To the Program Committee goes my deep appreciation for a difficult task well done.

The plan of the meeting remains the same as in other years, with an abundance of Refresher Courses, beginning Sunday, December 4, at 2:00 P.M. Other courses follow at 4:30 and 7:00 P.M. Sunday, at 8:30 A.M. and 10:30 A.M. on Monday, and at 8:30 A.M. on Tuesday through Friday. The popular Therapy Information and Film Interpretation courses will be continued.

Dr. John W. Walker and his Refresher Courses Committee will present in the October issue of this journal an application blank on which you may indicate your choices for the variety of subjects offered. Despite the increase in charges for attendance at these courses by *non-members* last year, the demand remained so great that all of the requests for certain courses could not be accommodated. *It is advisable, therefore, to register your choice early if you wish to attend a specific Refresher Course.* As last year, residents in radiology, trainees in physics, internes, and medical students will be accommodated in the largest rooms, the Caprice Pavilion and the Caprice Suite. If space is available at the start of the course, they will also be admitted to those courses held in smaller rooms.

On Monday afternoon, the first Scientific Session will be held. Payne S. Harris, B.S. (Physics), M.D., will deliver the Memorial Fund Lecture, speaking on "Radiation in Outer Space; Natural and Man Made." Following this will be papers on radiation protection. A member of the Congress of the United States, well informed on the radiation problem, will speak on its legislative implications.

On Wednesday morning we will be privileged to hear our only overseas guest, Dr. Ronald O. Murray of London, England. Consultant in Radiology to the Royal National Orthopedic Hospital and the Institute of Orthopedics, Dr. Murray will speak on "The Effects of the Adreno-Cortical Steroids on the Skeleton." To Dr. Murray and Mrs. Murray, who will accompany him, I extend a cordial welcome.

In accordance with the wishes expressed by a vote of the members last year, the

Scientific Sessions will not be designated A, B, and C but will be labeled Diagnosis, Therapy, Physics, Radiobiology, and General.

The essays have been grouped, so that the listener may obtain a maximum of information on related subjects in a short time. Whenever possible, the essayists have been urged by Dr. Everett L. Pirkey and his Scientific Exhibits Committee to present their material in exhibit form, so that those interested may study the subject at leisure. There will be an anonymous Scientific Exhibit Awards Committee. The diagnostic problem feature, "Case of the Day," will be continued.

The Work-In-Progress sessions, consisting mainly of short essays presenting the latest information on a variety of subjects, was so great a success last year that it will be continued, the Physics session being held on Wednesday afternoon and those for Diagnosis and Therapy on Friday morning. These represent required attendance for those who would keep abreast of the times.

My sincere thanks go to John Hale, Ph.D., and Warren K. Sinclair, Ph.D., for arranging the Physics programs and to John W. Clark, M.D., for planning the session on Radiobiology.

The Carman Lecture on Thursday evening will be delivered by Warren H. Cole, M.D., Professor of Surgery, University of Illinois. It was his work, under the guidance of the late Evarts Graham, M.D., that resulted in the successful radiographic visualization of the functioning gallbladder. For years the term "Graham-Cole test" was a synonym for the examination of the gallbladder by use of opaque media. Dr. Cole is currently President of the American Cancer Society. We are fortunate to have him share his wealth of knowledge and experience with us. Following the Carman Lecture will be the presentation of the Awards for Scientific Exhibits and the awarding of the Gold Medal of the Radiological Society of North America.

This year, as seldom before, the Society will rely on the work of the Local Committees, under the leadership of Justin E. McCarthy, M.D. Many problems, previously handled so unobtrusively by Dr. Childs, will rise to vex us. With the willing aid of the Local Committees and the indulgence of the Society members, we trust these will be kept to a minimum.

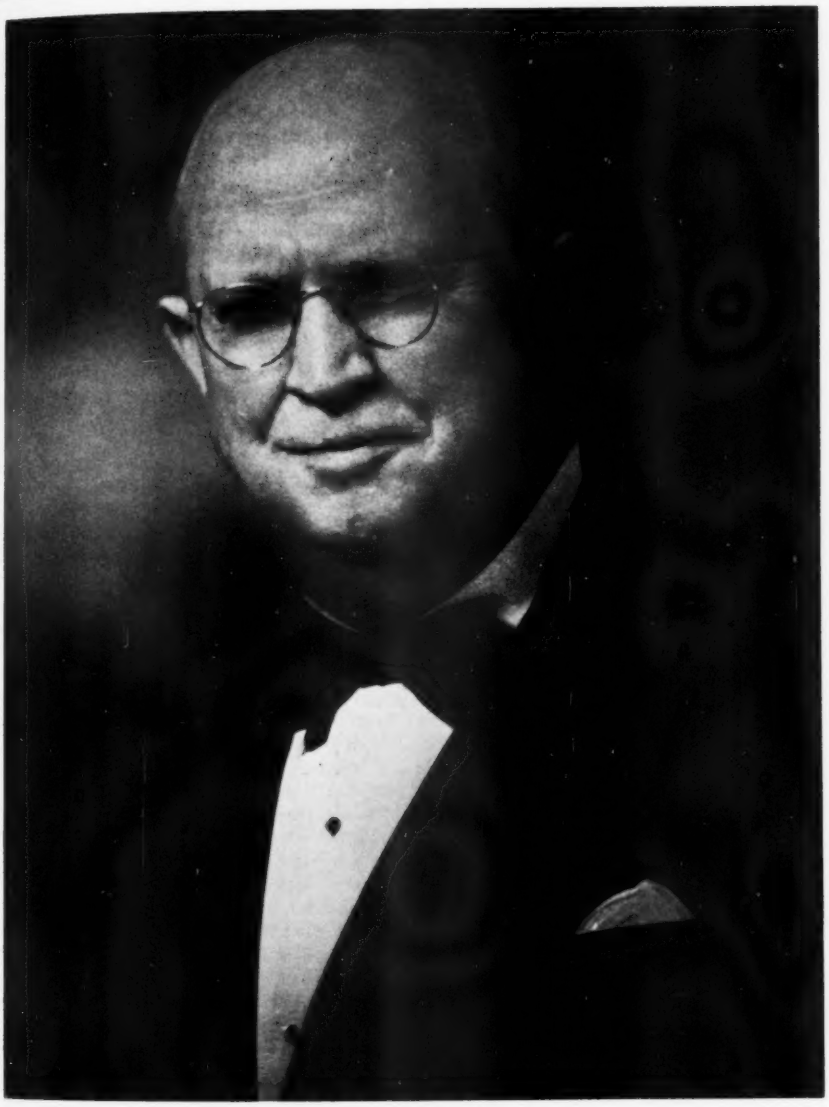
Mrs. Justin E. McCarthy and Mrs. Harry K. Hines are serving as co-chairmen of the Ladies Committee. Under their gracious direction an interesting and enjoyable round of events has been planned, not only for first time visitors to the "Queen City" but also for those who will be returning to enjoy its beauty and hospitality. A ladies' hospitality room will be maintained at the Netherland-Hilton Hotel and there will be a separate ladies' registration desk, which will also serve as an information center.

The Commercial Exhibits are one of the most attractive features of our annual meeting. This year we have a new Chairman of the committee, Claude R. Snead, M.D. He and his committee members have arranged for even more exhibit space than has been available at the Palmer House. This is welcome, since for several years past not all of the requests for space could be accommodated. On the part of the commercial exhibitors, I invite one and all to come and see the latest products of the manufacturers' art.

As I write this, I feel a great enthusiasm about the coming meeting. This has been generated by the hearty support of all those who were called upon to help in its preparation. Your attendance will repay their efforts.

T. J. WACHOWSKI, M.D.
*President*

# IN MEMORIAM



JAMES T. CASE, M.D.

1882–1960

A request to write an obituary notice of Dr. James T. Case represented a challenge which I accepted with reluctance, fearful that I could not do justice to the attainments of our beloved colleague. I accepted the assignment, however, because of my very close association with him for more than fifteen years as a trainee and associate in the practice of radiology, in tribute to our close friendship over a period of almost thirty years, and in an attempt to record the many accomplishments of this most unusual person, to serve as a stimulus to young and future radiologists.

On May 24, 1960, death closed the notable career of one of America's distinguished and most beloved

radiologists. The end did not come as quickly as he had hoped and prayed it might. Death was due to cancer, the disease he had helped to fight during his career as a radiologist of more than fifty-five years.

James T. Case was born to John Henry and Fannie Elizabeth (Roberts) Case in San Antonio, Texas, on January 5, 1882. At the age of five years he moved with the family to California. Following graduation from high school in Los Angeles, he took a job with the Pacific Press Publishing Company in Oakland, California. While working there he became interested in Dr. Kellogg and the opportunities offered at the Battle Creek Sanitarium, Battle Creek, Mich. His desire was to become a physician and to serve as a missionary in Mexico. Although circumstances altered this plan, Dr. Case held a life-long interest in Central and South America, making frequent trips there and receiving many honors from Latin American academies of medicine and radiology. He was graduated in 1905, with the degree of Doctor of Medicine, from the American Medical Missionary College in Chicago (merged with the University of Illinois School of Medicine in 1910). Following his graduation at the age of twenty-three, with Dr. Kellogg as his mentor, close friend, confidante, and traveling companion, he toured Europe, returning to become Surgical Assistant at the Battle Creek Sanitarium.

On Sept. 1, 1908, Dr. Case was married to Margaret Helena Kellogg, an adopted daughter of Dr. and Mrs. Kellogg. She also was a graduate of the American Medical Missionary College and engaged in practice until their son was born. It was in this same year that Dr. Case first engaged actively in radiology, though he had actually become interested in this field as early as 1903, when, as a student, he undertook some radiological studies of the movements of the intestine of the cat, following in the footsteps of the eminent physiologist, Dr. Cannon. Although he continued the practice of surgery until 1929, in conjunction with his work in radiology, being Surgeon-in-Chief from 1919 to 1929 at the Battle Creek Sanitarium, radiology was his real love. In these early years, with no opportunity for formal training in this country, he traveled to Europe for postgraduate study under the most distinguished men of the day: University of Vienna, 1907, 1911–1912, 1917; Radium Institute of Paris, 1912; University of Freiburg (Breisgau), 1907, 1921. He also studied in Hamburg (Haenisch), Munich (Reeder), and Frankfurt (Holfelder). In 1913 he was appointed Professor and first Chairman of the Department of Radiology at Northwestern University Medical School, Chicago, a position which he held until 1947, when be became Professor Emeritus. In 1929 he established his home in Chicago to devote his time to radiology as Chairman of the Department at Northwestern University Medical School and affiliated hospitals and shortly thereafter engaged in private practice in the Chicago Loop. For various periods he was radiologist at the following hospitals in the Chicago area: St. Luke's, U. S. Marine, Passavant Memorial, Evanston, and Highland Park. He served also as Consultant to the Veterans Administration and U. S. Public Health Service.

In 1951, Dr. Case disposed of his work in Chicago and returned to California, his old home, where he became Director of the Memorial Cancer Foundation, Santa Barbara, and member of the Radiological Department of Cottage Hospital. In this position he succeeded the late Dr. Henry T. Ullmann. At the Foundation his work in therapy represented another challenge which he thoroughly enjoyed, fostering the growth of this institution by adding a cobalt unit and expanding the use of radioactive isotopes. Here he was active in his work until incapacitated by illness.

Always interested in things Hispano-American, Dr. Case was often referred to as the Radiologic Ambassador to the Latin American countries—the Ambassador of Radiologic Good Will. It is significant that the June issue of *Radiologia*, the official organ of the Sociedad Radiologica Panameña, was in large part devoted to memorials to Dr. Case, with an editorial tribute by Dr. Arrieta Sanchez. Of particular interest is a proposal, in bold display, that the Inter-American College of Radiology, in collaboration with the leading American radiological societies, organize a movement to collect funds for the erection of a bust of Dr. Case in the gardens of the Pan-American Union in Washington, D. C. The respect and affection of his Latin-American colleagues is manifest also in the appended communication from Dr. Esguerra-Gómez, Bogotá, Colombia.

Not only did Dr. Case speak Spanish fluently but he had a ready command of French, German, and Italian, and nothing pleased him more than to be able to converse with colleagues from various countries in their own tongue. His significant contributions in the translations of the four-volume *Roentgen Diagnostics* by Schinz, Baensch, Friedl, and Uehlinger, *Borderlands of the Normal and Beginnings of the Pathologic in Skeletal Roentgenology* by Köhler and Zimmer, and more recently *Pediatric Roentgenology* by Lassrich, Prévôt, and Schäfer are well known to all English-speaking radiologists.

Dr. Case's international status as a radiologist was evidenced by the honors conferred on him by societies from three continents. Among these are the following: D.M.R.E. from Cambridge University, England, in 1921; Honorary Professor, University of San Marcos, Lima, Peru; Fellow of the Royal Society of Medicine, London; Honorary Member of the British Roentgen Society, Deutsche Röntgen Gesellschaft, Northern Association for Medical Radiology (Stockholm), New York Roentgen Society, Detroit Academy of Surgery, Sociedad de Cirugía of Peru, Academia de Medicina of Buenos Aires, Vienna and Austrian Roentgen Societies, the Radiological Societies of Spain, Mexico, Cuba,

Panama, and most of the countries of South America; Corresponding Member of the Academies of Medicine of Mexico, Cuba, Puerto Rico, Colombia, Brazil, and Peru, and of the Société Médicale des Hôpitaux de Paris and the Société de Radiologie Médicale de France. He held also the following honorary medals: Order of Merito Militar, Mexico, Orden de Merito "Carlos Finlay," Cuba, Orden de Boyacá, Colombia. The last of such distinguished citations were the Gold Medal of the Centre Antoine Béclère of Paris, which was bestowed *in absentia*, due to his illness, on February 3, 1960, at the Annual Meeting of the American College of Radiology in New Orleans, and a medal from the Société de Électrologie Française in commemoration of the anniversary of his honorary membership in that Society.

Throughout his life Dr. Case maintained an active interest in all of the radiological organizations of his own country. He was fellow or member of the following Societies: American College of Radiology (President, 1929); American College of Surgeons; American Gastroenterological Association; Chicago Roentgen Society (President, 1915); International College of Surgeons (International Treasurer); American Medical Association; American Radium Society (President, 1923; Janeway Lecturer and Janeway Medal, 1959); American Roentgen Ray Society (President, 1920; Caldwell Lecturer, 1939); Chicago Surgical Society; Radiological Society of North America (Carman Lecturer, 1936); Western Surgical Association; Los Angeles Radiological Society; Pacific Roentgen Society; Radiological Society of Southern California (President, 1954–1955). Other honors include the Gold Medal of the Radiological Society of North America (1937), the Gold Medal of the American Roentgen Ray Society (1939); the Gold Medal of the American College of Radiology, 1955; the Gold Medal of the Inter-American College of Radiology (President, V Inter-American Congress of Radiology, 1955).

His great work in diagnostic roentgenology and contributions to the literature, particularly the problems dealing with the gastrointestinal tract, earned him world-wide fame and attention. As early as 1914 he published a four-volume Stereoscopic Atlas Text on *X-ray Examination of the Digestive Tract*. His medical contributions include the first case of anencephaly diagnosed before birth. His pioneer work in roentgen recognition of colonic, duodenal and small bowel diverticula, his ileocecal and appendical studies, and his contributions to the subjects of colonic carcinoma and motor physiology of the colon are well known. He was first to use the Coolidge tube for therapy and the first to employ 200,000-volt x-rays. He made more than 100 contributions to medical journals. Dr. Case was the second Editor of the *American Journal of Roentgenology*, succeeding Dr. Hickey in 1916. His editorship of the Journal was interrupted by his activities in the first World War. He became head of the radiological section of the American Expeditionary Forces in France and following World War I remained active in the Army Reserve, resigning his commission as Colonel in 1937 after twenty-one years of military service.

Life for Dr. Case in the two years before his death was saddened by the prolonged illness of his beloved wife, Helena, who died at seventy-five on August 10, 1959. Never has there been a more devoted couple. Soon after her death the widespread extension of the malignant disease which took his life was discovered. This was known to only a few intimate friends and he continued his work until February 1960.

Dr. Case is survived by a son, Herbert R. Case of Orange, California; a daughter, Mrs. Margaret Cook of Santa Barbara; a sister, Mrs. Sidney Harris of Hollywood, California; and by six grandchildren and two great-grandchildren.

Here was a life replete with activity and achievement—a pioneer in radiology, whose contributions are permanently recorded in the annals of our specialty. Words cannot express adequately his attainments. He was an eminent physician, teacher, and author, a tireless and meticulous worker. Men of medicine all over the world held him in high regard. Probably no American radiologist was as well known personally and for his contributions in other countries, particularly those of South America, Central America, the Caribbean, and Europe. To have known Dr. Case was truly an inspiring experience. His energy and his enthusiasm were contagious. He will be sorely missed both professionally and personally by a multitude of friends and colleagues throughout the medical world.

EARL E. BARTH, M.D.

## A Tribute from Latin America

It was with deep grief that I learned of the death of Dr. James T. Case. An uninterrupted friendship of more than thirty years had served only to increase my tender feeling and admiration for the man who, more than any other, represented the bond of affectionate union between the radiologists of the United States and Spanish America.

Dr. Case was the very personification of friendship in the noblest sense of the word. Altruistically, with both hands, affably, without affectation, and with benevolence, he tried always to find the means to help, please, advise, and stimulate all those whom he considered to be his friends. And there were hundreds of them. Not only were they to be found

among his compatriots, but there is almost no radiologist in Latin-America who did not enjoy his most generous friendship.

The Congresses of Radiologists in Buenos Aires, Havana, Santiago, Mexico City, Washington, and Lima saw him, surrounded by his disciples, first in everything, not only as promoter and outstanding leader, but also as a permanent fellow-worker for the success of these reunions. The harmony and mutual understanding now existing between the radiologists of North and South America are due in large measure to Dr. Case. And this recognition of his accomplishments is made manifest not only in the moment of his death; all through his life it was expressed in the many acts and resolutions of the Inter-American Congress of Radiologists, which in 1933 named him President, as a sincere and unanimous demonstration of the affection in which he was held.

It is significant that Dr. Case never wanted to accept for himself or any of his North American colleagues the direction of the Inter-American College of Radiology, lest others might believe that they wished to direct and dominate it as representatives of the great nation of the North, while they were only seeking a union based on absolute equality among the different nations of the Continent. If the diplomatic relations of the United States had developed in the same way, there would be less misunderstanding and a greater inter-American cordiality.

We of Latin America wish the family, friends, and colleagues of Dr. Case in the United States to know of our sorrow at his loss. It is a grief that not only affects us personally, but is felt also by the members of the Colombian Society of Radiologists and the Colombian Government itself, which in 1955 paid homage to him by conferring upon him the highest order of the country, the Cross of the Order of Boyacá.

It will be difficult to fill the void left by this great friend and outstanding master. We can only hope that one or more of his colleagues among the younger radiologists of the United States of America will try to follow in the footsteps of the man who, for so many years, in such an altruistic manner, and with such success, not only contributed to the progress of radiology but also worked unceasingly to promote cordial relations between his fellow specialists in North and South America.

GONZALO ESGUERRA-GÓMEZ, M.D.
Clínica de Marly
Bogotá, Colombia

EMILE HERMAN GRUBBE

1875–1960

The last survivor of his group of pioneers in the science of radiology, Doctor Emile H. Grubbe died on March 26, 1960. His desire to contribute all his energies toward the advancement of the science of medicine through radiology remained to the end of his life and thus he declined interesting conversation unless it concerned correction of human disabilities, particularly cancer. This was only natural, since he claimed priority as the first to show tissue damage from roentgen rays.

Born in Chicago early on New Year's Day, 1875, of Swiss German stock, Doctor Grubbe was said to be a precocious child. Fortunately he had abundant home support for higher education, for travel, and for research. He was educated in the Chicago public schools and the University of Valparaiso, Indiana, and had private instruction in chemistry, physics, and electricity in this country and in Europe. Having discovered platinum in paying quantities in Idaho, he mined it profitably and was exploring new fields for its use, by introducing it into the manufacture of Crooke's tubes, when the threshold of skin tissue tolerance was exceeded on his left hand. This malady added another to the already towering roster of human disabilities, a new entity, radioepidermitis, with its subsequent degenerative effects, caused by the recently discovered X-light of Roentgen.

Before he had reached the age of twenty, Dr. Grubbe had established a laboratory on Pacific Avenue, now LaSalle Street, Chicago. As an assayer of rare metals he early gained a reputation for accuracy and honesty, lifetime characteristics, bringing him a clientele from the large financial institutions engaged in promoting the mining industry of that day. While manufacturing Crooke's tubes and in the quest of x-rays, their production and uses, his investigative mind led him to experiment with fluorescing crystals in the crude hat-box type of fluoroscope. In the course of these studies he exposed the skin of his face and neck to radiation beyond the point of tolerance. He also suffered excessive total-body irradiation, narrowly escaping death from blood dyscrasias, and incurred other disabilities, including sterility. His life was saved at this time, he believed, by consulting Sir William Osler, who suggested the newly developed medication of fresh ox blood and liver. While his sterility

was as yet not realized, it later became a major factor in his unhappy marital relations and the loneliness of his childless life.

The first x-ray apparatus in a Chicago hospital was designed, assembled, and operated by Doctor Grubbe in 1896 (the Hahnemann Hospital of Chicago). Among his other hospital connections of earlier years, Chicago Memorial, Baptist, Frances E. Willard, Streeter Memorial Hospital, and the Pine and Peekskill Sanitariums may be cited. His laboratory in Hahnemann Hospital became the nucleus of the first department for teaching radiology to students in a medical school (the Hahnemann Hospital and Medical College).

When the faculty of the Illinois College of Electrotherapeutics decided to include "and x-rays," Dr. Grubbe was given the responsibility of teaching this new division. In this period of expanding usefulness of x-rays, the shift of emphasis from electrotherapeutics toward radiology created opposing groups in medical practice, and x-ray and Roentgen societies were organized with only minor stress on electrotherapeutics. It was also a time in medical history when fiery tempers clashed, of bitter frustration, vigorous determinations, rigorous oppositions, and of hard fought victories from which there emerged entirely new concepts of pre- and postgraduate medical education, organization, and practice which created a real revolution in medical affairs.

This situation, coupled with mounting disabilities resulting from successive episodes of surgical amputations and tumor removals, marked a crucial point in Dr. Grubbe's professional career. Obviously his efforts to include x-rays in the old societies failed when the Chicago Roentgen Society, and the national radiological organizations were formed by different groups of physicians. He remained, however, a staunch supporter of organized medical bodies throughout his life and was a founding member of the Roentgen Society of the United States, later the American Roentgen Ray Society. He had been a member of the Radiological Society of North America since 1915.

Honorary awards were conferred by the American Institute of Medicine, the Walter Reed Society, the Chicago Roentgen Society, the American Cancer Society, and the Chicago Medical Society. Doctor Grubbe was a member of the Citizens Board of the University of Chicago, the American Congress of Physical Therapy (1938), the Association of American Physicians and Surgeons, the National Academy of Science, the American Association for Cancer Research, the National Society for Physical Therapeutics (President, 1912), the Illinois State and the Chicago Medical Societies, the Chicago Roentgen Society, the American Society for the Advancement of Science, the American Philosophical Society, the Chicago Philatelic Society (President, 1939), and the American Philatelic Society. He was a delegate to the International Electric Congress in 1904 and a Fellow of the American College of Physicians and the American Medical Association.

In the provisions of his will Doctor Grubbe established "The Emile H. Grubbe Radiation Therapy Foundation of the University of Chicago." Some ten years earlier he had made a gift to the John Crerar Library, Chicago, of his private library consisting of about a thousand volumes on roentgenography, roentgen therapy, and related technical subjects.

To appreciate the full significance of Doctor Grubbe's accomplishments, one must understand that he was ambitious, blessed with a storehouse of energy, strong physical endurance, a brilliant mind, all channeled into the single purpose of alleviating human suffering through medical science. With courage and fortitude he gave his all.

BENJAMIN H. ORNDOFF, M.D.

# ANNOUNCEMENTS AND BOOK REVIEWS

## CENTRAL OHIO RADIOLOGICAL SOCIETY

At a recent meeting of the Central Ohio Radiological Society, the following officers were elected: President, William H. Crays, M.D., Springfield; Vice-President, William Swartz, M.D., Columbus; Secretary-Treasurer, Robert L. Friedman, M.D., Grant Hospital, Columbus 15; Councilor to American College of Radiology, Paul A. Jones, M.D., Zanesville; Alternate, George Jones, M.D., Lancaster.

The Society meets on the second Thursday of October, November, January, March, and May, in Columbus, Ohio.

## COLORADO RADIOLOGICAL SOCIETY

Newly elected officers of the Colorado Radiological Society are: Morris Levine, M.D., Denver, President; Emanuel Salzman, M.D., Denver, Vice-President; Cyrus W. Partington, M.D., Colorado Springs, Treasurer; Bertram L. Pear, M.D., 3 Winwood Drive, Englewood, Secretary.

Meetings are held the third Friday of each month, September through May, at the Denver Athletic Club.

## SECTION ON RADIOLOGY, MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA

The Section on Radiology of the Medical Society of the District of Columbia has elected the following officers for the coming year: Charles E. Bickham, M.D., Chairman; John S. Hashim, M.D., Chairman Elect; William E. Sheely, M.D., 1746 K St., N. W., Washington 6, Secretary-Treasurer.

## RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY

The newly elected President of the Radiological Society of Greater Kansas City is Gerhard W. Schottman, M.D.; the Secretary-Treasurer is J. Stewart Whitmore, M.D., 1010 Rialto Bldg., Kansas City 6, Mo.

## IOWA RADIOLOGICAL SOCIETY

At its annual 1960 meeting, the Iowa Radiological Society elected the following officers: President, R. A. Berger, M.D., Davenport; President Elect, J. T. McMillan, M.D., Des Moines; Secretary-Treasurer, L. L. Maher, M.D., 1419 Woodland Ave., Des Moines; Executive Committee Member-at-Large, W. S. Thoman, M.D., Sioux City; Councilor to American College of Radiology, R. W. McConnell, M.D., Waterloo; Alternate Councilor, R. W. Blanchard, M.D., Waterloo.

## RADIOLOGICAL SOCIETY OF NEW JERSEY

Officers of the Radiological Society of New Jersey for the coming year are as follows: President, Andrew P. Dedick, M.D., Red Bank; Vice-President, W. Laurence Bonnet, M.D., Trenton; Treasurer, Jules H. Bromberg, M.D., Newark; Secretary, Austin J. Tidaback, M.D., 912 Prospect Ave., Plainfield; Councilor to the American College of Radiology, George G. Green, M.D., Asbury Park; Alternate Councilor, Andrew P. Dedick, M.D.

## OKLAHOMA STATE RADIOLOGICAL SOCIETY

The Oklahoma State Radiological Society, at a recent meeting in Oklahoma City, elected to office J. Murphree, M.D., Ponca City, President; Sam Glasser, M.D., Oklahoma City, Vice-President; E. D. Greenberger, M.D., Medical Arts Building, McAlester, Secretary; S. Pollack, M.D., Tulsa, Treasurer.

The Society has three regular meetings during the year: in January, May, and October.

## RADIOLOGICAL SOCIETY OF PUERTO RICO

At the June 9 meeting of the Radiological Society of Puerto Rico, in San Juan, the following officers were elected: President, Dr. Victor A. Marcial; Vice-President, Dr. Jorge Carreras-Girard; Secretary-Treasurer, Dr. César E. Rosa-Pérez, Fondo del Seguro del Estado, Parada 1, San Juan, P. R.

The Society meets the second Thursday of each month, at 8:00 P.M., at the Puerto Rico Medical Association Building in San Juan.

## INTERNATIONAL CONGRESS OF NEURORADIOLOGY

The next International Congress of Neuroradiology (VI Symposium Neuroradiologicum) will be held in Rome Sept. 18–22, 1961, under the Presidency of Dr. Giovanni Ruggiero. All correspondence relative to the Congress should be addressed to Dr. Enzo Valentino, General Secretary, VI Symposium Neuroradiologicum, CIT, Ufficio Congressi, p. Colonna 193, Rome, Italy.

## DR. RIGLER HONORED

On June 10, at the time of the Recognition Exercises of the Senior Class in Medicine at the University of Minnesota, Dr. Leo G. Rigler was cited as worthy of special commendation for outstanding achievement. The citation read:

"The Regents of the University of Minnesota, as a

token of high esteem, and in recognition of noted professional attainments by Leo G. Rigler, distinguished graduate of the University of Minnesota, highly respected former chief of the Department of Radiology at Minnesota, inspiring teacher, devoted scientist and author, progressive leader in the development of x-ray diagnosis in chest diseases, esteemed spokesman for internationally known radiological societies, deem him to be worthy of special commendation for outstanding achievement conferred on June tenth, nineteen hundred and sixty."

### DR. GLASSER HONORED

Dr. Otto Glasser, Cleveland, Ohio, was recently awarded the Commander's Cross of the Order of Merit of the Federal Republic of Germany, in recognition of his work on the life of W. C. Röntgen, and his contributions to radiology. Dr. Glasser is also holder of the Röntgen-Honor-Plaque and Honorary Curator of the Röntgen-Museum in Remscheid-Lennep.

### CHILDREN'S MEMORIAL HOSPITAL FELLOWSHIP

A Fellowship in Pediatric Roentgenology will be offered, beginning Jan. 1, 1961, by the Department of Radiology of the Children's Memorial Hospital, Chicago, to residents who have successfully completed at least two, and preferably three, years of training in radiology. Further details may be obtained from Dr. Harvey White, Chief, Department of Radiology, The Children's Memorial Hospital, 707 Fullerton Ave., Chicago 14, Ill.

## Letter to the Editor

### IMAGE INTENSIFIER RISK

*To the Editor of Radiology*

DEAR DR. DOUB:

I have been rather perturbed, when examining diagnostic units fitted for use with the electronic image intensifiers (image amplifiers), to observe the lack of attention paid to an obvious radiation hazard.

It concerns both the patient and the radiologist, or more frequently the surgeon. In each instance the hazard arises because the system adopted for viewing the x-ray beam and the beam-defining system are not closely related.

*Beam viewing* is done by an image intensifier with a circular screen. *Beam restriction* is usually done by means of movable plates giving a rectangular outline to the beam. These plates are positioned by the person viewing through the intensifier eyepiece and, surprisingly, it is necessary to remark that the beam so obtained can never coincide with the screen. The manufacturers may avoid irradiating the head and shoulders of the viewer by providing the usual type of viewing screen with lead glass backing as a surrounding shield to the image intensifier; they do not thereby remove the hazard to the patient nor to the hands of the radiologist. Further, the screen provided is of little use for viewing by the person using the image intensifier.

Because the field visualised is rather small, the most likely method of use is to open the rectangular beam-defining apertures until the intensifier is fully illuminated. The edges of the diaphragms are then lost from view and the x-ray beam therefore could illuminate a much larger area of the patient than is seen; also, the hands of the person manipulating the patient could enter the x-ray beam without being observed.

It is not sufficient to fit stops as an answer to this problem, so that the edges of the field become tangential to the circle seen through the intensifier, since the corners of such a field are still not visualised and may cause damage. It is usually possible, however, to fit a subsidiary circular diaphragm of just sufficient size to cover the screen of the intensifier, so interlocked that the screening circuits operate only when the diaphragm is in place.

When this has been done, the problem of alignment becomes evident. It is necessary that this should be routinely checked by the radiographer in charge of the machine, and some means whereby this alignment can be simply adjusted by the radiographer must be provided by the manufacturer.

F. W. TRANTER
Christie Hospital and Holt Radium Institute
Manchester, England

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

INTRA-OSSEOUS VENOGRAPHY. By ROBERT A. SCHOBINGER, M.D., Clinical Instructor in Surgery, Albert Einstein College of Medicine, New York, N. Y.; Section Chief, Surgical Service, Veterans Administration Hospital, Bronx, N. Y.; Formerly Associate Cancer Research Surgeon, Roswell Park Memorial Institute, Buffalo, N. Y. Foreword by Philip J. Hodes, M.D. A volume of 244 pages, with 317 figures. Published by Grune & Stratton, New York 16, N. Y., 1960. Price $14.50.

INDUSTRIAL PULMONARY DISEASES: A SYMPOSIUM HELD AT THE POSTGRADUATE MEDICAL SCHOOL OF LONDON, 18TH–20TH SEPTEMBER, 1957, AND 25TH–27TH MARCH, 1958. Edited by E. J. KING, M.A., D.Sc., F.R.I.C., Postgraduate Medical School of London, and C. M. FLETCHER,

C.B.E., M.D.(Cantab.), F.R.C.P., Postgraduate Medical School of London. A volume of 274 pages, with 98 illustrations. Published by Little, Brown & Co., Boston 6, Mass., 1960. Price $8.50.

TUMORS OF THE FEMALE SEX ORGANS. PART 2: TUMORS OF THE VULVA, VAGINA AND UTERUS. By ARTHUR T. HERTIG, M.D., Shattuck Professor of Pathological Anatomy, Harvard Medical School, Boston, Mass.; Consultant in Pathology, Boston Lying-In Hospital, Boston, Mass.; Free Hospital for Women, Brookline, Mass., and HAZEL GORE, M.B., B.S., Associate in Pathology, Harvard Medical School, Boston, Mass.; formerly Associate Pathologist, Free Hospital for Women, Brookline, Mass. Atlas of Tumor Pathology, Section IX—Fascicle 33. A volume of 278 pages, with 286 figures. Published by the Armed Forces Institute of Pathology under the auspices of the Subcommittee on Oncology of the Committee on Pathology of the Division of Medical Sciences of the National Academy of Sciences—National Research Council, Washington, D. C., 1960. For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington 25, D. C. Price $2.50.

MECHANISMS IN RADIOBIOLOGY. VOLUME II: MULTICELLULAR ORGANISMS. Edited by MAURICE ERRERA, Université libre de Bruxelles, Faculté des sciences, Bruxelles, Belgium, and ARNE FORSSBERG, Radiobiologiska Institutionen, Karolinska Institutet, Stockholm, Sweden. A volume of 396 pages, with numerous figures and tables. Published by Academic Press, New York 3, N. Y., 1960. Price $13.00.

IMMEDIATE AND LOW LEVEL EFFECTS OF IONIZING RADIATIONS. Edited by A. A. BUZZATI-TRAVERSO. Proceedings of the Symposium Held at Venice on June 22nd–26th, 1959, under the Joint Sponsorship of U.N.E.S.C.O., I.A.E.A. and C.N.R.N., and published as a Supplement to the International Journal of Radiation Biology. A volume of 382 pages, with numerous figures and tables. Printed and published by Taylor & Francis, Ltd., Red Lion Court, Fleet Street, London, E. C. 4, England, 1960. Price $8.00 plus postage.

PROCEEDINGS: SYMPOSIUM ON SOME PROBLEMS OF NORMAL AND ABNORMAL DIFFERENTIATION AND DEVELOPMENT, ROSCOE B. JACKSON MEMORIAL LABORATORY, BAR HARBOR, MAINE, JUNE 15 THROUGH 17, 1959. Edited by NATHAN KALISS, Symposium Chairman, Assistant Director (Research), Roscoe B. Jackson Memorial Laboratory. Honorary Chairman: Clarence C. Little, Director Emeritus, Roscoe B. Jackson Memorial Laboratory. National Cancer Institute Monograph No. 2. A paper-bound volume of 188 pages, with 9 plates. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1960. Price $1.25.

ATLAS DER ANGIOKARDIOGRAPHIE ANGEBORENER HERZFEHLER. By Dr. RALPH KÜNZLER and Dr. NIKOLAUS SCHAD, Assistenten der medizinischen und chirurgischen Abteilung der Universitäts-Kinderklinik Zürich. With a foreword by Prof. Dr. Guido Fanconi, Direktor der Universitäts-Kinderklinik Zürich and Prof. Dr. Max Grob, Chefarzt der Chir. Abteilung der Universitäts-Kinderklinik Zürich. Fortschr. a. d. Geb. d. Röntgenstrahlen, Ergänzungsband 86. A volume of 224 pages, with 416 illustrations on 91 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1960. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 85.—($20.25); to subscribers to the Fortschritte, DM 76.50.—($18.20).

QUADRI RADIOLOGICI DELLE PNEUMOPATIE INTERSTIZIALI IDIOPATICHE E SISTEMICHE NELL'ADULTO. By E. BALESTRA, Istituto di radiologia dell'Università di Genova. A monograph of 196 pages, with 63 figures. Published by Edizioni Minerva Med., Turin, Italy, 1960.

## Book Reviews

INTUSSUSCEPTION IN INFANTS AND CHILDREN. By MARK M. RAVITCH, M.D., Associate Professor of Surgery, The Johns Hopkins University School of Medicine; Surgeon-in-Chief, The Baltimore City Hospitals, Baltimore, Md. A volume of 122 pages, with numerous figures, including 118 roentgenograms. Published by Charles C Thomas, Springfield, Ill., 1959. Price $9.00.

This volume on Intussusception is the first of a newly projected series of Pediatric Surgical Monographs to be published under the general editorship of the author, Dr. Mark M. Ravitch, of Johns Hopkins University. The subject is covered in five chapters, dealing with matters of Historical Interest, The Clinical Picture, Errors in Diagnosis, Pathological and Experimental Studies, and Treatment.

The clinical features of this condition are comprehensively covered. Radiologists will be especially interested in the chapter on treatment. The author presents an excellent description of the surgical indications and the choice and technic of operation, which, however, is used only if a barium enema fails to reduce the intussusception. In a series of 77 cases seen from 1939 to 1958, treated primarily by barium enema, there were no deaths. In a series of 21 cases treated prior to that time by

primary operative reduction, the mortality was 24 per cent. The author cautions against undue pressure during administration of the enema; under no circumstances does he raise the container of barium more than 3 feet 6 inches above the table. Manipulation is also avoided.

The monograph is unusually well illustrated with charts, line drawings, and radiographs. There is an excellent bibliography.

This book should be of great interest to radiologists, pediatricians, and others who are concerned with the diseases of childhood.

MEDULLARY SPONGE KIDNEY: A ROENTGENOLOGIC, CLINICAL, HISTOPATHOLOGIC AND BIOPHYSICAL STUDY. By TORE EKSTRÖM, BENGT ENGFELDT, CURT LAGERGREN, and NILS LINDVALL. From the Department of Urology, the Department of Diagnostic Roentgenology, Karolinska Sjukhuset, Stockholm, and the Department of Pathology II, University of Uppsala, Uppsala, Sweden. A monograph of 104 pages, with 32 figures. Published by Almqvist & Wiksell, 26 Gamla Brogatan, Stockholm, C, Sweden, 1959. Price Sw. kr. 18:—(about $3.40).

This excellent little book is a roentgenologic, clinical, histopathologic, and biophysical study of the medullary sponge kidney. It is based on the authors' experience with 44 patients with this disease.

The chief roentgen findings are given as follows:

1. Small cystic cavities in the region of the renal papillae are the first structures to be filled by contrast medium on excretory pyelography and they remain filled after the renal pelvis empties. Not all these cavities fill by retrograde pyelography.
2. There is usually good concentration of contrast medium.
3. Generalized renal enlargement was seen in 14 cases.
4. Calcifications were very common. They were eventually present in all but 4 cases.
5. The cavities were larger than the concretions that they contained.
6. The disease was bilateral in 27 of the cases.

The findings are considered to be very characteristic in most cases. Differential diagnosis includes renal tuberculosis, renal papillary nephrosis, nephrocalcinosis, calyceal diverticula, and tubular stasis.

The authors discuss, also, the clinical aspects and the gross and microscopic anatomy of the lesion. The specimens were further studied by microradiography and x-ray crystallography. One of the interesting findings was that calcifications were composed of apatite, while "normal" renal calculi seldom contained this component. The treatment and prognosis are discussed, as is the etiology. The authors believe that medullary sponge kidney is a congenital malformation which is not related to polycystic disease, as was held by early writers.

The illustrations are of very good quality. The material is well organized and clearly discussed. This book should prove a valuable source of information on a comparatively little known condition. It can be highly recommended.

RADIATION BIOLOGY OF VICIA FABA IN RELATION TO THE GENERAL PROBLEM. By JOHN READ, B.Sc., Ph.D., The Hugh Adam Research Department of the Medical School and the New Zealand Branch of the British Empire Cancer Campaign, University of Otago, Dunedin, New Zealand. A volume of 270 pages, with 74 figures and 41 tables. Published by Charles C Thomas, Springfield, Ill., 1959. Price $10.50.

There is certainly no other experimental material in radiobiology about which as much is known as the broad bean root, *Vicia faba*. Work done on many different materials is difficult to correlate, because of the dangers inherent in extrapolation. This is obviated here.

The present text begins with the culture of the roots and the measurement of their growth, which would be helpful to a beginner in this field. Various radiation effects—inhibition of mitosis, chromosome breaks—are described. Factors which influence response include dose rate, fractionation, and oxygen. The current interest in oxygen had its beginnings here. The book closes with a discussion of the significance of this work in relation to the radiotherapeutic problem.

Anyone interested in research in radiobiology or in the action of radiation as a basis for radiotherapy will find a wealth of information in this volume. It is well and clearly written, and the material is well organized.

THE DEVELOPMENT AND THE EMBRYONIC ANATOMY OF THE HUMAN GASTRO-INTESTINAL TRACT: A NEW BASIS FOR THE STUDY OF ANOMALIES OF THE GASTRO-INTESTINAL TRACT. By NIELS LAUGE-HANSEN, Medical Dr., R., Chief Radiologist, Centralhospital, Randers, Denmark. A volume of 86 pages, with 176 figures. Published by Centrex Publishing Co., Eindhoven, Netherlands, 1960.

In his work on anomalies of the gastrointestinal tract the author was led to a study of embryology in order to explain his observations more clearly. He investigated the normal anatomy of the embryo and the development of the intestinal tract, and then turned to the anatomy of embryos in which developmental defects and anomalies were present. The results of his studies are recorded in this monograph.

The text is profusely illustrated by photographs and drawings, most of which are in color. Not many radiographs are reproduced and these are not of good quality.

This work will be of particular interest to the student who desires a short description of the embryology of the gastrointestinal tract.

PHOTOGRAPHY IN MEDICINE. By ARTHUR SMIALOWSKI, Director, Department of Photography, St. Michael's Hospital, Toronto, Canada, and DONALD J. CURRIE, M.D., M.Sc., F.R.C.S.E., F.R.C.S.(C.), D.S., F.A.C.S., Attending Staff Surgeon and Consultant to the Department of Photography, St. Michael's Hospital, Toronto, and Clinical Teacher, Department of Surgery, Faculty of Medicine, University of Toronto, Toronto, Ont., Canada. A volume of 330 pages, with 282 figures. Published by Charles C Thomas, Springfield, Ill., 1960. Price $14.50.

This book, according to the preface, is not intended to be a complete treatise on medical photography but rather a guide for those interested in this field. This is borne out in the text, as many important aspects of the subject are covered in a few pages. Those who wish detailed discussion of cameras, lenses, etc., will not be satisfied. The authors, however, have assembled a great deal of information on the organization of a photographic department and the basic equipment needed. They discuss the various photographic procedures which are carried on in a hospital, such as copy work, photomicrography, photography of gross specimens and of patients from the various hospital departments. Motion picture photography is treated rather casually.

While not an exhaustive text, this volume should be of interest and value to those who wish information on the organization and everyday work of a medical photographic department.

KLINISCHE RADIOLOGIE DES MAGENS UND DES ZWÖLFFINGERDARMS. By DR. PIERRE PORCHER, Paris, Membre de l'Académie nationale de médecine, Membre de l'Académie de chirurgie, Radiologiste de l'Hôpital Saint-Antoine et de l-Hôpital Américain; Dr. HANS-ULRICH STÖSSEL, Bern, Ancien assistant étranger de l'Hôpital Saint-Antoine, Medizinische Poliklinik der Universität Zürich (Prof. Dr. R. Hegglin); and DR. PAUL MAINGUET, Brussels, Médecin Résident étranger des Hôpitaux de Paris. With a foreword by Prof. Dr. med. H. H. Berg, Hamburg. A volume of 264 pages, with 468 illustrations on 260 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1959. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 72.—($17.15).

In this work the three authors present a concise review of their current methods of radiographic study of the upper gastrointestinal tract, particularly the stomach and duodenum. This is not a conventional textbook in that the emphasis is on special studies of this region, with particular attention to the functional diagnosis of gastric and duodenal disease. Apparently all three writers employ drugs extensively to control peristaltic activity and muscular tone. Morphine and atropine find almost routine use in any examination in which an obviously normal stomach is not first observed fluoroscopically. In difficult cases, and particularly those in which the differential diagnosis lies between inflammatory changes in the stomach and a neoplasm, parietography is utilized. By proper positioning, following induction of pneumoperitoneum the gastric wall can be outlined either against air or against its barium content. A large number of excellent radiographs based on this procedure are presented.

The book is divided into three portions, the first concerning the conventional radiography and fluoroscopy of the stomach and duodenum, the second featuring the drugs mentioned above, and the third on parietography.

This is a well bound, well illustrated volume, easily read, and fortunately not written with such a love of words as to be boring to those who already have a foundation in radiology.

ERGEBNISSE DER GESAMTEN TUBERKULOSE- UND LUNGENFORSCHUNG. BAND XIV. Edited by ST. ENGEL, London, L. HEILMEYER, Freiburg i. Br.; J. HEIN, Tönsheide, and E. UEHLINGER, Zürich. A volume of 736 pages, with 462 illustrations on 283 figures. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 144.—($34.30).

This fourteenth volume of studies on tuberculosis and other aspects of pulmonary pathology opens with a tribute to Stefan Engel, who has long been associated with this series, by his co-editors and the publisher. The first six papers in the present collection are concerned with the clinical, radiologic, pathologic, and therapeutic aspects of pulmonary vascular disease. A broad review of this subject has been attempted by co-ordinating the coverage of the various contributors as requested by the editors. It is recognized that pulmonary vascular disease in many ways complements but in other ways differs from similar diseases of the greater circulation. Except for the much discussed cor pulmonale, it has been a neglected subject. This series of contributions on vascular disease continues the sequence of reports on basic investigations which, in Volume XIII, carried the reader through the chemotherapy of pulmonary tuberculosis. Ten recognized European medical authorities collaborate in these six presentations. The subject matter is as follows:

1. "Comparative Anatomy of the Respiratory Tissue in Mammals and Humans," by Stefan Engel.

2. "Normal Anatomy of Pulmonary Vessels," by G. Töndury and E. Weibel.

3. "Pathologic Anatomy of Pulmonary Lung Vessels, Particularly in Connection with Pulmonary Hypertension," by G. Könn.

4. "The Pathology of the Bronchial Arteries," by J. B. Armstrong and L. Cudkowicz.

5. "Tuberculosis and Blood Flow," by D. Esch and F. Grosse-Brockhoff.

6. "Post-Mortem Angiographic Studies of the Lungs," by J. Schoenmackers and H. Vieten.

The papers which form the last half of the book are of more general nature. Atelectasis in childhood is discussed by Görgényi-Göttche and Kassay, with obvious emphasis on foreign-body inhalation. Further studies submitted are on diseases of the mediastinum, infectious tuberculosis in teachers and nursing personnel, Boeck's sarcoidosis, and the fate of mucopolysaccharides in the lungs. One offering, that by Adelberger and Schindler, is of interest to the surgeon: the comparison of pulmonary resection versus collapse therapy in tuberculosis.

This work is on the profound side; it is of undoubted high quality but would be of most use to the man in an academic environment. Its verbosity would tend to limit its audience to doctors with more than usual spare time for reading.

# ABSTRACTS OF CURRENT LITERATURE

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# ROENTGEN DIAGNOSIS

## THE HEAD AND NECK

**The Subarachnoid Cisterns. An Anatomic and Roentgenologic Study.** Bengt Liliequist. Acta radiol. Suppl. 185, 1959. (Serafimerlasarettet, Stockholm, Sweden)

The author has carefully studied the normal anatomy of the subarachnoid cisterns, comparing the appearances of these spaces as seen on anatomic preparations and on encephalographic examination.

Twenty-five cadavers, twenty-two to eighty-two years of age, known to be free from cerebral disease, were utilized. The subarachnoid spaces were filled with a solidifying mass injected with the brain *in situ*. Two types of injection material were used. In some a fluid, cold-polymerizing resin was employed to make plastic casts of portions of the cisterns by dissolving the surrounding brain substance. Others were injected with a gelatin solution containing barium sulfate, and roentgenograms were taken both with the brain *in situ* and again after its removal and formalin fixation prior to dissection. The usual encephalographic projections were made, including lateral, anteroposterior, postero-anterior, and half-axial. Additional views were made of the removed brain to demonstrate certain anatomic details, and tomograms were also employed.

The encephalographic material was obtained from a review of all examinations carried out at Serafimerlasarettet (Stockholm) from 1955 to 1957. All cases showing any expansive process or atrophic change were excluded as well as any with poor filling of the subarachnoid cisterns. There remained 120 cases selected for more detailed study, the large majority of these representing patients under fifty years of age because of the prevalence of cortical and central atrophy in the older groups.

The terminology and classification of the cisterns has been the subject of considerable controversy, and this subject with its historical background is reviewed. The author uses the nomenclature of Key and Retzius with few exceptions. He classifies the subarachnoid cisterns into three major groups as follows: the cisterns in the posterior cranial fossa, the suprasellar cisterns, and the cisterns in the tentorial notch.

Included in the posterior fossa group are (1) the cisterna magna, (2) cisterna medullaris, (3) cisterna pontis, and (4) the two pontocerebellar cisterns. The cisterna medullaris, lying ventral to the medulla oblongata, communicates broadly with the cisterna pontis and is considered a separate cistern rather than a part of the cisterna magna.

There are two main suprasellar cisterns; the author, as is customary, dividing this large subarachnoid space anterior to the pons into the (1) cisterna interpeduncularis and (2) cisterna chiasmatis, with the tuber cinereum and infundibulum forming the boundary between them. Other cisterns in this group are (3) the cisterna laminae terminalis, (4) the olfactory sulci, and (5) the cisterna cruralis. This last space is a lateral continuation of the cisterna interpeduncularis (which covers the inferior and lateral surfaces of the crura cerebri) and has not been previously described as an independent cistern, being regarded by others as a part of either the ambient or interpeduncular cistern.

In the third large group are placed those spaces which lie in the tentorial notch or are closely related to it. Included are (1) the cisterna corporis callosi, (2) the cisterna quadrigeminalis, which lies above the quadrigeminal plate and is commonly called the cisterna venae magnae Galeni, (3) the ambient cistern, enveloping the brain stem, (4) the wings of the ambient cistern and the cisterna veli interpositi, which extends above the roof of the third ventricle, and (5) the cisterna cerebelli superior, which lies around the superior vermis.

Each cistern is discussed from the anatomic and the roentgenologic point of view, with an account of its boundaries, the structures within it, and projections necessary for maximum radiologic visualization. The large amount of factual material presented does not lend itself to simple summation beyond the classification as outlined. The monograph is recommended in its entirety to all those interested in neuroradiology.

Ninety-three roentgenograms, plus photographs, diagrams, and graphs.

CHARLES M. GREENWALD, M.D.
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**Intracranial Chordoma.** Remzi Demir and A. Theodore Steegmann. Neurology **9**: 514–521, August 1959 (Kansas University School of Medicine, Kansas City, Kans.)

A case of intracranial chordoma in a 44-year-old man is reported to emphasize the difficulties in diagnosis of this tumor, even though improvements have been made in recent years in the technics employed to demonstrate intracranial mass lesions.

The tumor in the present case arose from the clivus blumenbachii and spread upward and forward to invade the sella turcica and sphenoid sinuses. The pons was compressed backward. The symptomatology of intracranial chordoma varies from patient to patient, depending on the direction of extension of the mass, but the clinical characteristics are in general those emphasized by Bailey (Intracranial Tumors, 1948, p. 349): a slow course, with late appearance or absence of intracranial hypertension; early appearance of cranial nerve palsies, which may dominate the clinical picture; pyramidal tract or cerebellar signs produced by compression rather than invasion of the cerebral and cerebellar peduncles; pain and stiffness of the neck resulting from extension of the tumor in the direction of the foramen magnum. All of these signs and symptoms were present in the authors' case with the exception of pain and stiffness of the neck, which were absent because the foramen magnum was not invaded. Occipital headache was the initial complaint.

The value of roentgenography in the diagnosis of chordoma has been emphasized [see, for example, Wood and Himadi: Radiology **54**: 706, 1950]. A chordoma should be suspected when bone destruction or a soft-tissue mass is visualized in the spheno-occipital and hypophyseal areas in the midline—since most of these tumors arise in the region of the clivus. A basilar view of the skull is therefore particularly important. The dorsum sella is usually destroyed first and, after the tumor has invaded the sella, destruction of the posterior clinoids and hypophyseal floor follows. The anterior clinoids are eventually destroyed. In the authors' case, a roentgenogram of the skull provided

the first objective evidence of tumor. The floor of the middle fossa was eroded; the roof of the sphenoid could not be identified and, on one side, the basilar foramina appeared wiped out. Pneumoencephalography proved of additional value, showing a soft-tissue mass extending from the cisterna chiasmatica back to the level of the cisterna interpeduncularis. Angiography was of no help in this case.

Failure to obtain tumor tissue by two nasal biopsies precluded a pathologic diagnosis but gave some support to the opinion that the tumor was not primarily of nasopharyngeal origin. The patient received a course of x-ray therapy without benefit and died about fifteen months after the onset of symptoms. Only the brain was available for necropsy examination; the gross and microscopic appearance of the tumor was characteristic and similar to that in previously reported cases.

Seven figures, including 1 roentgenogram.

**Tumors of the Temporal Bone.** Piero Meda, Gian Battista Leonardelli, and Pier Luigi Cova. Arch. Otolaryng. **70**: 471-484, October 1959. (Via F. Sforga, 35, Università di Milano, Milan, Italy)

Under the heading of tumors of the temporal bone the authors have classified all neoplasms known in the past as "tumors of the middle ear," "tumors of the middle and external ear," "tumors of the petrous bone," and "tumors of the mastoid process." Primary and secondary tumors are differentiated as follows: All new growths affecting, exclusively or pre-eminently, the temporal bone structure or the surrounding vessels, nerves, and muscles, as well as those penetrating into the temporal bone, are considered *primary*. They include epithelioma and connective-tissue tumors of the middle ear, true cholesteatoma, tympanic and jugular paraganglioma, neurinoma of the facial and acoustic nerves, and meningiomas. *Secondary tumors* are those of the external ear, of the skin of the periaural region, of the parotid gland or the nasopharynx, and intracranial tumors, such as neurinoma of the acoustic nerve, meningioma, and some types of jugular paraganglioma which originate in anatomical formations not related to the temporal bone, affecting the latter only in part, during the later stages of their growth or by a metastatic process.

The information obtained from roentgen examination of the temporal bone has increased in recent years, thanks to the employment of tomography, to the possibility of enlarging the roentgen picture, and to the use of x-ray tubes having a moving anode with a very small target. Stereoscopic views and some of the new radiographic projections permit the demonstration of nearly all the details of the bone. Therefore roentgenography is essential, both in the early stages of tumor growth and in the presence of gross lesions. In the early tumor, tomography is of great help in evaluating the site of the lesion and its extension. Chaussé's second projection for the jugular fossa should always be employed, as it may contribute information which cannot be derived in any other way, even by tomography. The x-ray picture of the temporal bone which is being invaded by a new growth is always the same. In primary and secondary tumors, there is a destruction of the bone due to the osteolytic activity of the tumor. It should be remembered, however, that metastases from tumors of the prostate, the thyroid, and the breast are usually of the osteoplastic type. The granular appearance of bone structures, which is often observed in temporal bone tumors, may sometimes be related to a true neoplastic infiltration; in other cases it is conditioned by a concomitant inflammatory process. It is not possible to differentiate chronic destructive inflammatory forms from initial neoplastic processes. The latter are often associated with inflammation. Extensive lesions in which the surrounding bone tissue shows an erosive aspect are usually neoplastic.

The different types of tumor of the temporal bone are discussed according to the following histological classification: epithelial tumors, true cholesteatoma, connective-tissue tumors, bone-tissue tumors, nervous-tissue tumors, and metastatic tumors. Attention is called to the fact that leukemia and systemic lymphosarcoma may infiltrate the temporal bone.

The clinical signs and the syndrome presented are tabulated for 32 cases.

Twenty-five figures, including 11 roentgenograms; 4 tables.

**Hemangioma of the Base of the Cranium and Its Roentgen Characteristics.** A. Tänzer. Fortschr. a. d. Geb. d. Röntgenstrahlen **91**: 633-638, November 1959. (In German) (Martinistr. 52, Hamburg-Eppendorf, Germany)

Hemangiomas of the bones are relatively rare and are for the most part located in the bones surrounding the central nervous system. About half of them are in the spinal column, while second in order of frequency is the skull, chiefly the parietal bones. In the base of the skull these tumors are extremely rare, only 9 cases having been described in the literature.

The author reports a case of his own, in a 43-year-old man who had undergone a radical left mastoid operation on account of profuse bleeding from the ear in 1943. Since then he had been deaf in the left ear. He came to the author's clinic in 1947, on account of a retro-auricular fistula, but attempted operation had to be interrupted on account of severe hemorrhage. A paralysis of the left posterior cerebral nerves followed. In 1950 the patient returned with renewed hemorrhage from the ear, which was checked with great difficulty. Histologic examination showed hemangioma. There was paralysis of the 7th, 8th, 9th, and 11th nerves. After intensive x-ray treatments the patient improved considerably and was able to return to work.

Roentgen examination revealed extensive bone destruction of the left temporal bone, involving mainly the pyramid and suggesting a malignant tumor. In the occipital bone, however, two x-ray characteristics were found that pointed to the diagnosis of hemangioma—the well known honeycomb-like appearance and, on another film taken in a different projection, an arrangement of the bone trabeculae in the form of radiating light rays. There also was widening of the various foramina in the left side of the base of the skull. Clinically a soft-tissue mass could be felt under the left ear. This pulsated and on auscultation the characteristic murmur was noted.

Seven roentgenograms.

WILLIAM A. MARSHALL, M.D.
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**Hemangioma of the Jaws. Review of the Literature and Report of a Case.** Howard W. Smith. Arch. Otolaryng. **70**: 579-587, November 1959. (789 Howard Ave., New Haven 4, Conn.)

Hemangiomas of the maxilla and mandible are

extremely rare, although they probably occur more frequently than the number of recorded cases would indicate. The author tabulates the findings in 28 cases from the literature and reports an additional case, involving the mandible, in a 25-year-old woman. Presenting symptoms were mucosal bleeding in 6 cases, swelling in 8, pain in 1, and a throbbing sensation in 3. Three cases were asymptomatic, and in 11 the symptoms were not given. In 3 cases, including the author's, the early symptoms were dependent upon the presence of teeth. Bleeding from the mucosal surface around the teeth occurs long before any large area in the bone is defined. While most gingival bleeding consists of an indolent ooze, that associated with hemangioma is of a spurting character. This stops upon extraction of the teeth and, when the bone lesion suddenly begins to enlarge, other symptoms make their appearance.

Hemangiomas should be considered more frequently in the differential diagnosis of radiolucent lesions of the jaws. Roentgen examination is especially helpful in the larger lesions of the mandible undergoing active proliferation. The picture is one of multicystic areas of bone resorption, producing a soap-bubble or honeycomb effect. The areas of resorption are irregular in outline, with indefinite borders which blend into the normal bony architecture. Fine trabeculations are seen in some instances and large cavities in others. Erosion of the lamina dura, with resorption and displacement of the dental roots, has been reported. The cortex of the bone may become thinned, expanded, and, in some cases, eroded through. Geschickter and Maseritz (J. Bone & Joint Surg. **20**: 888, 1938. Abst. in Radiology **32**: 250, 1939) observed several small punched-out areas distal to the lower border of the tumor, which they regarded as indicative of progression and typical of angioma. The findings described here have been of assistance in mandibular lesions but are not particularly helpful in those of the maxilla. The nasal and paranasal sinus cavities, plus superimposed cranial structures, make the changes less distinctive in the upper jaw roentgenogram. Unfortunately, the small, early lesion, which is equally hazardous, has no distinguishing roentgenologic characteristics.

The management of hemangioma of the jaws is discussed. Deaths have been recorded from lesions both large and small, as the result of surgical interference. The greatest danger to the patient is not from any potential malignant aspect of the tumor but from the imminent possibility of fatal hemorrhage. In the author's opinion, radiotherapy would seem to be the procedure of choice in lesions in which control of bleeding is not urgently needed. Unfortunately, tooth extraction often leads both to diagnosis and to need for hemorrhage control.

Surgery in the case reported was followed, in one month, by x-ray therapy to the jaw for a total dose of 2,464 r over a period of twenty-nine days. Eight months after completion of the irradiation, facial asymmetry had disappeared and symptoms of pressure in the jaws and lip numbness had markedly decreased. Roentgenograms showed a filling in of the active zone of destruction with new bone. There were a decrease in size of the larger bone cavities and increased density of the surrounding bone, with visualization of the mandibular canal.

Four roentgenograms; 1 photograph; 1 table.

**Angiography in Head Trauma.** J. Pecker, A. Javalet, and Ch. Stabert. J. de radiol. **40**: 623–638, November 1959. (In French) (Clinique neurochirurgicale de Rennes, Rennes, France)

The principal problem in head injury is the occurrence of post-traumatic hematomas, and it is only since the introduction of carotid angiography that rapid and marked progress has been reached in their diagnosis.

It was impossible for the authors to review all the information that may be obtained from angiography in cases of cranial traumatism. They offer, however, an interesting clinical and radiological study of several cases, showing the value of this relatively simple investigation, which they found always to be innocuous.

Twenty-five roentgenograms with accompanying diagrams.

RENÉ HOURI, M.D.
New York, N. Y.

**Simultaneous Biplane Large-Film Serialography in Cerebral Angiography.** Harold G. Jacobson and Jerome H. Shapiro. Am. J. Roentgenol. **82**: 773–778, November 1959. (Montefiore Hospital, New York 67, N. Y.)

This is a report on the adaptation of the Elema-Schönander biplane unit, primarily designed for cardioangiography, to cerebral angiography in two planes. Magnification of structures occurs in both planes because the head is raised 3 inches above the anteroposterior film changer and is 4 to 5 inches from the lateral film changer.

Because of the advantages of biplane serialography with a single injection of opaque medium, the disadvantages of magnification, in the order of 10 to 15 per cent, are outweighed, in the authors opinion.

The technic of exposure is described. The usual speed in this study was 3 films per second for nine seconds.

Ten roentgenograms; 3 photographs.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

**Pneumoencephalography and Air Embolism: Simulated Anesthetic Death.** Jay Jacoby, John R. Jones, John Ziegler, Leon Claassen, and John P. Garvin. Anesthesiology **20**: 336–340, May–June 1959. (Division of Anesthesiology, Ohio State University, Columbus, Ohio)

During the ten-year period, January 1948 to January 1958, general anesthesia was administered to 1,196 patients for pneumoencephalography at Ohio State University Hospital. Of these, 895 were children and 301 were adults. There were 7 major complications, with 6 deaths, during the procedure. Five of the deaths were in children. The diagnosis of air embolism was made and confirmed at autopsy in 4 cases; 1 patient had clinical signs of air embolism but permission for autopsy was refused; 1 patient died of herniation of the brain stem. The seventh complication, another example of brain stem herniation, occurred in a 49-year-old man; resuscitation was successful, but death eventually ensued as a result of the brain lesion. In each of these cases the physiologic changes resulting from air embolism or herniation of the brain stem appeared rapidly and were manifested by abrupt embarrassment or cessation of respiration and circulation. These signs are usually ascribed to the anesthesia rather than to the surgery.

During pneumoencephalography the onset of respiratory and circulatory collapse should bring to mind two diagnostic possibilities: herniation of the brain stem is most likely after lumbar puncture but before air injection; air embolism is most likely after air has been introduced. Immediate recognition and prompt treatment of these complications may prevent a fatal outcome. The surgeon or anesthesiologist should listen constantly to the heart during the procedure. The beginning of a murmur is a signal to stop the injection of air. Autopsy and roentgenography are of value in establishing the correct diagnosis when such complications occur and death is attributed to the anesthesia.

Two roentgenograms; 1 table.

**Roentgenologic Manifestations of Glioma of the Optic Nerve and Chiasm.** Colin B. Holman. Am. J. Roentgenol. **82**: 462–471, September 1959. (Mayo Clinic, Rochester, Minn.)

A study was made at the Mayo Clinic of the roentgenograms in 48 proved cases of glioma involving the optic nerve or optic chiasm, or both. Routine roentgenograms of the head were normal in 12 of 13 patients in whom only the optic nerve was involved. In 7 of 9 patients in this group, in whom roentgenograms were made in the Rhese position, gross enlargement of the optic foramen on the affected side was evident; in the remaining 2 the tumors were entirely intraorbital.

In 35 patients the gliomas involved the optic chiasm. In 4 of this group routine roentgenograms were considered normal. Most of the changes observed in the other patients involved portions of the sphenoid bone extending from the planum sphenoidale posteriorly to the dorsum sellae. The region of the chiasmatic sulcus showed a large concave depression in 8, and a more shallow depression in 8 others. Seven patients had roentgen evidence of increased intracranial pressure.

Almost half of the tumors involving the chiasm were associated with changes in the inferior aspect of the anterior clinoid processes and that portion of the sphenoid bone between the limbus of the planum and the tuberculum. These sphenoidal changes, although not pathognomonic, should suggest the possibility of glioma of the optic chiasm, especially when accompanied by enlargement of one or both optic foramina or an appropriate visual disturbance.

There was no instance of roentgenologically demonstrable tumor calcification in the entire series.

Pneumoencephalography, performed in 3 cases, demonstrated in every instance obliteration of the cisterna chiasmatis and lamina terminalis, posterior dislocation of the anterior portion of the third ventricle, and an outline of part of the suprasellar tumor in the cisterna interpeduncularis.

Ventriculography, done in 4 cases, showed severe obstruction of the foramen of Monro in 3 instances and incomplete obstruction in 1.

In 2 cases in which angiograms were obtained the results were considered normal.

Seventeen roentgenograms.

**Anaplastic Carcinoma of the Larynx Occurring in a Young Woman.** John Storer and Edward Goodsitt. Arch. Otolaryng. **70**: 466–470, October 1959. (E. G., 3951 Terrace Rd., Cleveland 12, Ohio)

Tumors of the larynx are comparatively rare in women, and particularly so in the younger age groups. The authors report a case of highly malignant oat-cell carcinoma in a 28-year-old woman seen shortly after a full-term delivery, in June 1956. The patient complained of a sore throat and some difficulty in swallowing for several months prior to delivery. She had spent three years in a concentration camp in Russia and had been hospitalized for one year in Germany for treatment of malnutrition and tuberculous lymph nodes. X-ray examination on the present admission revealed two small out-pouchings in the midportion of the esophagus at the level of the hilus. These had the appearance of ulcerative lesions, and it was thought that they might represent early diverticula or possibly ulcerations from extension of the tuberculous lymph nodes. The patient had a strong psychosomatic component, and it was felt that her difficulty was most likely functional in nature and that there was no organic basis for her complaints. She continued to complain, however, of difficulty in swallowing and an abnormal sensation in the throat. Findings on biopsy of a cervical lymph node, in December 1956, were compatible with a diagnosis of inactive tuberculous adenitis. Bronchoscopy and laryngoscopy showed no evidence of abnormality.

In April 1957, the patient was again admitted to the hospital because of "shortness of breath, a chronic cough, and weight loss." At this time she disclosed that in 1943, while in Germany, she had received an extensive course of x-ray therapy to her tuberculous lymph nodes (no details concerning dosage were available). Laryngoscopy was again performed and showed some limitation of movement of the vocal cords and narrowing of the larynx just inferior to the cords. The bronchoscope could not be passed beyond this obstruction. A biopsy of tissue in this area revealed a small-cell carcinoma, and x-ray therapy was delivered to three portals in the cervical region for a total of 1,500 r to each portal. Some improvement followed, but after a number of weeks the patient returned, complaining of pain in the spine. Roentgen examination now showed pulmonary metastases scattered throughout both lungs, but no evidence of bone involvement. Death occurred in November 1957. Necropsy revealed widespread metastases.

The possible relationship of the laryngeal cancer to the previous x-ray therapy is discussed.

Three figures.

## THE CHEST

**A Radiological Analysis of Disseminated Lung Disease.** David M. Gould and Glenn V. Dalrymple. Am. J. M. Sc. **238**: 621–637, November 1959. (D. M. G., University of Colorado Medical Center, Denver)

Systematic interpretation of the x-ray film by the radiologist and careful analysis of clinical possibilities with the attending physician should lead to a higher degree of diagnostic accuracy in cases of disseminated lung disease. Several conditions produce distinctive patterns in the lung, but the assignment of a definite etiology is usually not possible from the film alone. Attention to historical information provided by the patient, along with symptoms, physical examination, and laboratory studies, may exclude a large number of possibilities or may be crucial in arriving at the correct etiology. Geographical and epidemiologic factors must also be considered.

Systematic analysis of the films includes (1) description of the lesions, including size, number, density, and type of margin of the individual x-ray shadow; (2) anatomical location of the lesion, whether in the bronchoalveolar tract, vascular or lymphatic system, or reticuloendothelial interstitial system; (3) probable pathology; (4) pathogenesis and route of dissemination (How did the lesion form? What changes in anatomic structures are responsible for its formation? Was the method of dissemination through the bronchus or by way of the vascular or interstitial system?).

Following a consideration of these points, a differential diagnosis can be constructed. Attention should be given to any ancillary evidence on the films or in the history. Follow-up films and special studies may be of great value in enabling the radiologist to approach the correct diagnosis.

This excellent and thoughtful analysis should be of great value to all radiologists and chest physicians who are faced with the problem of diagnosing disseminated lung disease.

Three roentgenograms; 5 tables.

RICHARD H. GREENSPAN, M.D.
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**The Diagnosis of Emphysema: A Physical Sign, A Roentgenographic Sign, and an Oximeter Test.** C. R. Woolf. Am. Rev. Resp. Dis. **80**: 705–715, November 1959. (University of Toronto, Toronto, Ont., Canada)

A total of 258 subjects were studied in an attempt to make the diagnosis of emphysema, or to exclude it, on the basis of three simple signs.

The physical sign was the level of the dome of the right diaphragm in the mid clavicular line in relation to the anterior ribs. In the great majority of subjects in whom the lung border was palpable at the level of the 7th rib or below it, emphysema was found to be present, while nearly all of the subjects without emphysema were found to have a lung border at or above the 6th anterior interspace.

The roentgenographic sign was the level of the right diaphragm in relation to the posterior ribs as demonstrated on what was termed the "surprise" chest film. In this examination the patient was positioned in the usual manner but was given no instructions as to how to breathe. A chest film was then taken without cessation of respiration. It was found that if the right diaphragm was at the level of the 11th rib or below on this roentgenogram, the patient probably had emphysema. In only one subject without emphysema was the diaphragm at or below this level. On the other hand, there were some emphysematous patients in whom the diaphragm was at the level of the 10th interspace or above.

The third sign had to do with the 90 per cent desaturation time. The subject was given oxygen and the arterial oxygen saturation was recorded by a direct writing ear oximeter. When the saturation had reached a plateau, oxygen administration was stopped and the subject was allowed to breathe room air. The 90 per cent desaturation time was then calculated as the time in seconds from the cessation of oxygen breathing until the arterial oxygen saturation had fallen 90 per cent of the way to its original level. It was found that a time of 350 seconds was a convenient dividing point. The normal subjects had desaturation times of less than 350 seconds, while those with pulmonary emphysema generally had longer desaturation times. There were very few exceptions to those general rules.

It is concluded that these three rather simple procedures are of considerable value in determining the presence of emphysema, particularly when the results of the three tests agree.

Six figures, including 2 roentgenograms; 6 tables.

JOHN H. JUHL, M.D.
University of Wisconsin

**Roentgenographic Evaluation of Primary Carcinoma of the Lung.** Kenneth D. McGinnis. J. Kentucky M. A. **57**: 1351–1355, November 1959. (Lexington Clinic, Lexington, Ky.)

This paper is one of a group comprising a symposium on the diagnosis and management of primary carcinoma of the lung. The information is generally basic, but some points meriting particular consideration may be mentioned:

It is now generally accepted that early diagnosis of clinically asymptomatic lesions is essential if cure rate is to be improved. When bronchogenic carcinoma becomes clinically evident, the chance for cure usually has been lost. In relatively rare instances can evaluation by radiologic methods alone give evidence sufficiently strong that no histologic examination is required. Conventional radiologic studies ordinarily cannot reliably predict operability of lung carcinoma unless multiple nodules or distant metastases indicate absolute inoperability.

A solitary uncalcified lung nodule proves to be malignant in approximately 40 per cent of cases. The author stresses the usefulness of the laminagram in the evaluation of solitary nodules to demonstrate more effectively the presence or absence of calcium, which is a critical feature. Extensive or concentric calcification is an almost certain sign of a benign process. While calcification may occur within a malignant nodule, it occupies a relatively small area compared to the entire size of the lesion and tends to be finely punctate.

The earliest and frequently the only manifestation of small endobronchial lesions is differential aeration of a segment or lobe with or without mediastinal shift, features which can ordinarily be satisfactorily demonstrated only by fluoroscopy. Slow clinical improvement or slow roentgenographic clearance in endobronchial lesions with obstruction is an indication for early bronchoscopy. In older age groups, segmental atelectasis must be considered as due to neoplasm until proved otherwise.

In the study of hilar mass lesions the author has found laminagraphic examination helpful. The absence of discrete margins and a normal appearance of the proximal bronchi indicate a probable inflammatory process. A few comments are made on the value of special studies in this connection.

Twelve very small roentgenograms are utilized to demonstrate the points under discussion, but absence of finer detail detracts from their value.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Rheumatoid Lung Disease: Report of a Case Which Developed in Childhood.** Geoffrey L. Brinkman and Leo Chaikof. Am. Rev. Resp. Dis. **80**: 732–737, November 1959. (The Henry Ford Hospital, Detroit, Mich.)

Lung disease associated with rheumatoid arthritis

was first described in 1948 and since then a number of cases have been published. The present paper concerns a child in whom roentgen changes in the chest were noted at the age of six years. This is the earliest age at which the condition has been reported. She deteriorated progressively and died of respiratory insufficiency at the age of fifteen years.

The patient had pneumonia and whooping cough at six weeks of age and during the first eight years of life had ten attacks of pneumonia, each requiring hospitalization. Chest roentgenograms taken in 1949, at the age of six, showed scattered areas of infiltration in both mid-lung fields and subsequent films showed this to be gradually increasing. At the age of thirteen, extensive diffuse bilateral fibrotic changes were noted, associated with hilar node enlargement. In addition to evidence of rheumatoid arthritis of the elbows, knees, ankles, fingers, and toes, there was also evidence of pulmonary osteoarthropathy (clubbing of the fingers but without specific mention of periosteal changes). A left lung biopsy was performed when the patient was thirteen. At operation the lung was found to be studded with small, grayish avascular nodules. The margins of the lung appeared gray and avascular. The gross appearance was that of a granuloma. Microscopically there was evidence of fibrosis, pleural thickening, and chronic inflammation.

The etiology was uncertain but the process was believed to be related to the patient's rheumatoid arthritis. Despite steroid therapy, the pulmonary disease progressed and the patient expired in August 1958 at the age of fifteen. At autopsy the lung was found to be markedly honeycombed by small cysts, many of which were drained by small bronchioles. The larger cysts were lined by cuboidal epithelium. Alveolar septa were markedly thickened with an infiltration of lymphocytes, a few plasma cells, and fibroblasts. The alveoli contained proteinaceous material and varying numbers of lymphocytes. Some of the areas of lymphocytic infiltration into the interstitial tissues had a nodular appearance. The synovia of the knee and hip joints showed the changes of rheumatoid arthritis.

The findings are believed to represent lung lesions associated with rheumatoid arthritis even though there was no distinct granuloma formation. Cyst formation and fibrosis were major features, with little residual normal parenchyma.

One roentgenogram; 2 photomicrographs; 3 photographs.

JOHN H. JUHL, M.D.
University of Wisconsin

**The Clinical and Roentgenological Courses of Pulmonary Paragonimiasis.** Sze-Piao Yang, Chin-Tang Huang, Chin-Sung Cheng, and Lan-Chang Chiang. Dis. of Chest **36**: 494–508, November 1959. (National Taiwan University Hospital, Taipei, Taiwan, China)

Data are drawn from more than 300 proved cases of pulmonary paragonimiasis seen since 1947 in the National Taiwan University Hospital. Forty cases were closely followed from three to ten years, and 5 came to autopsy. The authors review briefly the life history of the parasite *Paragonimus westermani* and present in detail the clinicoroentgenologic course of this fascinating disease. The eating of raw or partly cooked land crabs is the most common method of infection and appeared to be responsible for all of the cases summarized here.

The authors divide lung fluke disease into three definite stages:

(*1*) *Stage of migrating larvae.* Clinical manifestations of the disease may first appear a month or more after infestation. Roentgen findings include pleurisy with or without effusion, pneumothorax, and transient pneumonic or bronchopneumonic infiltrations without segmental or lobar distribution. Subcutaneous creeping tumors, abdominal or chest pain, cough, blood-streaked sputum, and general malaise are observed in this stage, which lasts three to twelve months or even longer.

(*2*) *Stage of mature worms.* The main clinical feature of the second stage, in which the mature worms are alive in the lungs, is a recurrent, bloody, characteristically chocolate-colored sputum containing ova of the parasite. Radiographic findings include nodular or cystic-nodular shadows in both lungs, with a changeable degree of perifocal infiltration. An important differential point is the demonstration of a small central rarefaction within the nodule, representing the burrow left by the worm, plus a small central cyst in which it is contained. Secondary pleurisy, often loculated, and pyopneumothorax occur in this stage. Any of these processes may disappear spontaneously. The duration of the second stage is variable and depends partly on the efficacy of treatment. The authors feel that the disease is active as long as the worms are alive, as manifested by the presence of cystic nodules or cavities within the lung tissue.

(*3*) *Stage of recovery.* All clinical symptoms and signs may completely disappear, with resultant resolution of the abnormal chest findings seen during earlier studies. Frequently residual hard nodules or even calcified foci will remain in the lungs. Fibrotic lesions are also observed.

The present paper presents considerable additional material, including the clinical features of each stage, serial chest x-ray findings, laboratory data, and some differential diagnostic points. Important clues for differentiation from inflammatory processes of the lungs and pleura attributable to other cause include: high eosinophilia in the peripheral blood as well as in the pleural effusion; the frequent bilateral manifestations; the transitory character of the radiographic shadows; the lack of fever.

The best available treatment still appears to be multiple emetine injections, but response is variable and by no means entirely satisfactory.

Radiographic points under discussion are demonstrated by 24 small reproductions, which unfortunately fail to show the finer details. Five brief case histories are included.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Late Progression of Pulmonary Coccidioidomycosis.** Maurice J. Small. Arch. Int. Med. **104**: 730–740, November 1959. (VA Hospital, East Orange, N. J.)

Four cases observed in the past two years strongly indicate that coccidioidomycosis, contrary to the commonly held concept, may not manifest itself until a considerable time after exposure in an endemic area. The disease may undergo late, continued, slow progression and spread by the bronchial route from cavities previously considered benign to produce infiltrations years later in the lung, indistinguishable roentgenographically from those of exudative tuberculosis.

Since all of the author's cases were encountered in

persons residing in the eastern part of the United States, and the x-ray manifestations did not become evident until five months to many years after documented residence in a known endemic area, it would appear that late pulmonary coccidioidomycosis must be added to the list of diagnostic possibilities when considering stationary or progressive coin lesions of the lung, cavitary lesions without positive bacteriology for tuberculosis, and parenchymal infiltrations resembling tuberculosis. A carefully taken history eliciting residence in an endemic area and coccidioidin and tuberculin skin tests have been the most helpful measures in leading to a positive diagnosis of late, active, pulmonary coccidioidomycosis. Physicians everywhere must be alert to this possibility.

Nineteen illustrations, including 15 roentgenograms.

**Association of Cardiac Pulmonary Haemosiderosis and Fibrosis.** Philip Ellman and R. A. M. Oliver. Brit. M. J. **2**: 988–990, Nov. 14, 1959. (St. Stephen's Hospital, London, England)

Hemosiderosis in the lungs was first noted by Virchow in 1858, and its association with valvular heart disease was observed by Fahr in 1928, in 2 cases of mitral stenosis and 1 of aortic incompetence. Such endogenous hemosiderosis has generally been held to lead to fibrosis. The authors report 2 cases, however, which suggest that the condition may be less fibrogenic than has been supposed.

One patient was a man of forty-five years with a history of acute rheumatic fever associated with joint involvement at the age of seven, and two episodes of pneumonia. At twenty-two, dyspnea and recurrent hemoptyses were noticed, with physical signs of mitral stenosis and auricular fibrillation. Radiological examination showed gross bilateral pulmonary miliary mottling and moderate left auricular enlargement with visible systolic pulsations. Mitral valvotomy was done in 1952, and lung biopsy showed hemosiderosis. After operation, there was no recurrence of hemoptysis, heart size returned to normal, and miliary mottling disappeared in the pulmonary area. Exercise tolerance was increased.

The other patient was a man of forty-one who had had mitral stenosis at the age of eleven. He was rejected by the army and worked as a van driver. He later experienced dyspnea and hemoptysis, with several episodes of bronchitis. Physical examination showed signs of right ventricular enlargement. A chest film revealed left auricular and right ventricular enlargement with pulmonary hemosiderosis. Laminagrams showed a calcified mitral valve. Valvotomy was followed by relief of dyspnea and hemoptysis, and the patient was able to work for three years. Dyspnea and hemoptysis recurred, however, and a chest radiograph showed generalized miliary mottling of both lung fields. Death followed an episode of acute pulmonary edema.

These 2 patients had suffered hemoptysis for twenty and six years, respectively, and in both a miliary pattern was demonstrable on the chest films. In the first case, valvotomy was successful and the lung fields gradually cleared. In the second case, in which valvotomy was not possible due to calcification of the valve, necropsy showed heavy focal hemosiderosis but no significant fibrosis.

The radiographic finding of mitral pulmonary hemosiderosis is held by the authors to be no contraindication to mitral valvotomy. Complete and gradual disappearance of miliary lung infiltration may be obtained.

Four roentgenograms; 2 photomicrographs; 1 photograph. CLARO L. MONTECER, M.D.
Cleveland Metropolitan General Hospital

**Pulmonary Changes in Hydantoin Therapy.** Matthew T. Moore. J.A.M.A. **171**: 1328–1333, Nov. 7, 1959. (1813 Delancey Place, Philadelphia, Penna.)

Of 31 epileptic patients on hydantoin therapy, 27, or 87 per cent, showed radiological changes in the form of "accentuated bronchovascular markings" or "diffuse pulmonary fibrosis." The author suggests that the lung changes represent an allergy reaction to the drug. There appears to be an inverse relation, however, between the incidence of these findings and the more familiar hydantoin gingival hyperplasia. Although the pulmonary change is not specific, it should be recognized as a possible hydantoin effect.

A case is reported.

Five roentgenograms; 2 photomicrographs; 1 photograph; 1 table. WILLIAM MARTEL, M.D.
University Hospital, Ann Arbor, Mich.

**An Investigation of Effects of Opaque Media on the Lungs with Comparison of Barium Sulfate, Lipiodol and Dionosil.** J. S. Dunbar, G. B. Skinner, G. Wortzman, and J. R. Stuart. Am. J. Roentgenol. **82**: 902–926, November 1959. (J. S. B., 2300 Tupper St., Montreal, P.Q., Canada)

This report concerns an investigation of the effects of various radiopaque contrast media on the tracheobronchial tree. Barium sulfate suspended in water, aqueous Dionosil, and Lipiodol were compared with water by experimental instillation into the tracheas of rats. A total of 174 rats were injected.

Roentgenographically, water caused no consistent change; Dionosil was uniformly reabsorbed within seven days; Lipiodol was diminished in amount but still present at one month; barium suspension had diminished only slightly in one month and had not entirely disappeared in four months.

Microscopically, water produced a slight polymorphonuclear and mononuclear cellular response, and minimal fibrosis in a few rats. Dionosil led to moderate edema at six hours, and moderate cellular reaction for the first twenty-four hours. Barium in water was followed by a moderate early inflammatory response without edema or late necrosis or fibrosis. Lipiodol produced mild cellular reaction; and necrosis and fibrosis were noted at four months, slight in amount but greater than with other media. Barium in sucrose solution caused early edema and later inflammatory cellular response. No one of the media investigated appeared to be clearly more damaging to lung parenchyma than the others.

The authors suggest that in investigating swallowing disorders in infants, barium should not be suspended in sucrose solution. They feel that preliminary injection of Dionosil Aqueous into the esophagus should be made, to be followed by barium in water, orally, if no opaque medium has entered the trachea.

The article incorporates a complete and excellent review of the literature, with 112 references.

Sixteen roentgenograms; 12 photomicrographs; 2 photographs; 2 tables. DON E. MATTHIESSEN, M.D.
Phoenix, Ariz.

**Report of a Case of Tracheal Bronchus.** D. Teskeredzić. Schweiz. med. Wchnschr. **89:** 1265-1266, Nov. 28, 1959. (In German) (Militärspital, Sarajevo, Yugoslavia)

The author describes a rare instance of tracheal bronchus which was clearly demonstrated bronchographically. This was a displaced posterior branch of the right upper lobe bronchus which had undergone cystic change and which on a plain anteroposterior film had the appearance of cavitation of the right lung. The correct diagnosis was established only on bronchoscopy and bronchography.

Four roentgenograms.

**Bronchographic Observations of Alterations of the Tracheobronchial Tree in Congenital Angiocardiopathies.** P. C. Gamalero, G. Bono, and E. Grassi. J. belge de radiol. **42:** 551–568, 1959. (In French) Clinique de pédiatrie de l'Université de Turin, Turin, Italy)

The authors have made bronchographic investigations in 40 patients with congenital cardiovascular disease and have observed morphological, topographical, and anatomo-functional changes of the tracheobronchial tree. The morphological and topographical changes consist in compression and deviation of the trachea and the main bronchi; the anatomo-functional changes are bronchial "rigidity" and cylindrical and pouch-like ectasia.

Deviation and compression are considered to be present most often in forms characterized by malposition and ectasia of the main vessels, as tetralogy of Fallot and interauricular communications.

Bronchial lesions and suppuration are more frequently found in association with congenital cardiovascular diseases, characterized by an increased cardiac output.

The authors stress the importance of investigation, especially for appropriate pre- and postoperative treatment.

Twelve roentgenograms. RENÉ HOURI, M.D.
New York, N. Y.

**Changes in the Bronchi in Pneumonia.** J. Háber, G. Benkö, and K. Barna. Fortschr. a. d. Geb. d. Röntgenstrahlen **91:** 576–582, November 1959. (In German) (Garai-u. 3, Pécs, Hungary)

Bronchoscopic and bronchographic studies of the lungs in pneumonia are being done mainly in cases of delayed resolution to study the relationship between that disease and bronchiectasis.

The authors wished to determine what demonstrable changes occur in the bronchi in the most acute stage of pneumonia and whether the findings would justify routine bronchoscopic and bronchographic examinations for therapeutic reasons. They therefore subjected 57 patients, mostly young people, to a bronchoscopic and bronchographic examination as soon as their fever had subsided or, if they were otherwise in good condition, even during the febrile period. Examinations were made during the first seven days of the disease, always during the period of infiltration, again four to six weeks later and, in case of positive roentgen findings, still again after an interval of nine months. The pneumonia usually extended over one or two segments, mostly in the left lower lobe, right lower lobe, and right upper lobe. The microscopic examination showed streptococci (usually following virus infection) in 23 cases, pneumococci in 13, and mixed infections in 10.

Bronchoscopy revealed acute inflammation in the bronchi of the involved area in 52 cases.

The bronchographic examination disclosed interrupted filling in 8 cases and insufficient advancement of the contrast material in 7 cases. In 13 cases definite pathological changes of the bronchial walls were demonstrated, "bronchitis deformans" in 11 and bronchiectasis in 2. "Bronchitis deformans" was explained as due to an infiltrative bronchitis and peribronchitis in contradistinction to "bronchitis superficialis." While the superficial bronchitis never leads to bronchiectasis, the infiltrative bronchitis may destroy some of the musculature and some of the elastic fibers, producing a deformity of the bronchi and bronchiectasis.

Re-examination of the patients showed that almost all of these changes had disappeared. They are therefore thought to have been due to inflammatory contraction or relaxation. Even in the 2 cases of bronchiectasis a normal bronchogram was obtained after six months, so that the authors consider these to have been only "pseudobronchiectasis."

On the basis of this study, it is concluded that bronchoscopic and bronchographic procedures should not be routinely done in pneumonia but should be reserved for those cases in which the history shows previous respiratory symptoms of long duration or in which normal recovery is delayed.

Eight roentgenograms; 3 tables.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

**The Diagnosis and Classification of Mediastinal Masses. I. A Study of 782 Cases.** Harold A. Lyons, George L. Calvy, and Billy P. Sammons. Ann. Int. Med. **51:** 897–932, November 1959. (450 Clarkson Ave., Brooklyn 3, N. Y.)

This is an excellent review of the roentgenographic features presented by masses in the mediastinum and a recital of the major points in differential diagnosis. Reference to the original article is recommended to the readers of RADIOLOGY.

Passive observation of mediastinal masses, or therapeutic irradiation for diagnostic purposes have happily been supplanted in recent years by more aggressive methods in diagnosis. Among these, the use of angiocardiography and scalene node biopsy have contributed greatly. By their use, unnecessary or premature operations are often avoided. While clinical and radiological studies can lead to an accurate presumptive diagnosis in about 80 per cent of cases, the vast majority of mediastinal enlargements require thoracotomy for positive identification.

Scalene node biopsy has shown its greatest value in cases of lymphoma, certain granulomas, and mediastinal or pulmonary tumors. Angiocardiography has facilitated diagnosis in vascular lesions such as aneurysm, coarctation, or cardiac abnormalities.

In 782 patients reported in this article, the most common tumors were found to be lymphomas. There were 203 patients in this category, and 146 of them had Hodgkin's disease. Inflammatory masses numbered 278, of which 160 were Boeck's sarcoid. Neoplasms of the mediastinum amounted to 123, the most common being teratoid and dermoid tumors (35) and metastatic growths (34).

Of the whole series, 42 per cent of the mediastinal masses were histologically malignant. Because of

this, and because many others were life-endangering by size or position, the point is reiterated that, when other methods do not establish the diagnosis, thoracotomy is mandatory. In the words of the authors, "Procrastination does not serve the best interests of the patient."

Twenty-seven roentgenograms; 2 photographs; 3 tables. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Acute Atrophy of the Thymus Induced by Adrenocorticosteroids: Observed Roentgenographically in Living Human Infants. A Preliminary Report.** John Caffey and Charles di Liberti. Am. J. Roentgenol. **82:** 530–540, September 1959. (Babies Hospital, New York 32, N. Y.)

Apparent mediastinal enlargement on routine films, due to the thymus, has been noted by the authors and other observers. Following stresses such as pneumonia, starvation, surgery, suppuration of pleurisy, or ionizing radiation, atrophy of the thymus with consequent shrinkage of the central image has also been observed. With the termination of stress, regrowth and even overgrowth of the gland was demonstrable in some of these cases.

The authors found that oral administration of Prednisone and Triamcinolone produced rapid shrinkage of the thymus in 7 of 8 cases in which idiopathic widening of the mediastinum has been discovered by chance on random films. Rapid thymic regrowth and overgrowth occurred in 3 cases following discontinuance of the oral steroids.

Fluctuation in size of the mediastinum observed during and following oral administration of corticosteroids explains, in part at least, the causal mechanism for variation in size of the central image found commonly in roentgenograms of both healthy and sick babies. It is suggested that stress may stimulate the pituitary-adrenal axis to secretion of increased amounts of steroids which produce acute atrophy of the thymus, followed by regrowth and overgrowth. Other and perhaps unknown internal stresses may be significant.

Corticosteroid shrinkage of the central mediastinal image makes possible accurate mensuration of cardiac size where enlarged thymic lobes fuse with the cardiac silhouette, producing an erroneous impression of cardiomegaly. It also makes possible differentiation of a conspicuous triangular widening of the mediastinum by the right lobe of the thymus from atelectasis of the right upper lobe of the lung, segmental pneumonic consolidation of the right upper lobe, and loculated mediastinal pleurisy.

Whenever prolonged administration of adrenocorticosteroids is employed, the effects on the thymus should be considered. It is possible that subsequent overgrowth of the thymus may, in special circumstances, lead to malignant lymphoid tumor and leukemia.

Thirty roentgenograms. R. S. BASILI, M.D.
St. Vincent's Hospital, New York

## THE HEART AND BLOOD VESSELS

**Radiologic Features of Isolated Ventricular Septal Defects.** Edward B. Singleton, Dan G. McNamara, and Denton A. Cooley. Arch. Surg. **79:** 715–723, November 1959. (1200 M. D. Anderson Blvd., Houston 25, Texas)

Pertinent radiographic features of isolated ventricular septal defects were correlated with pressure in the pulmonary circulation and the volume of intracardiac shunts, as observed in 150 surgically treated patients. The following classification was arrived at:

1. Small defects with small left-to-right shunt and no pulmonary hypertension. These show a normal roentgenologic appearance of the heart, and pulmonary vascularity is not appreciably altered.

2. Medium-sized defects with a moderate left-to-right shunt and moderate elevation in pulmonary systolic pressure (40 to 60 mm. Hg). Here pulmonary vascularity is increased and the undivided pulmonary artery segment is prominent. Abnormal hilar pulsations are not, as a rule, identified. Left ventricular enlargement of varying degree is present, and the majority of cases show enlargement of the left atrium as well.

3. Large defects with left-to-right shunt and with moderate elevation of pulmonary arterial pressure (more than 60 mm. Hg and less than the systemic pressure). These cases show, in addition to the features under 2, right ventricular enlargement and greater dilatation of the pulmonary artery segment. The left atrium is also dilated to a greater degree. The pulmonary vascular markings are greatly accentuated. Abnormal hilar pulsations may usually be identified.

4. Large defects with about equal pressure in pulmonary and systemic circulations and a predominantly left-to-right shunt. Such defects cause moderate cardiac enlargement. Both right and left ventricles are enlarged, but not the left atrium. Peripheral pulmonary vascular markings may be decreased. Hilar vessels and the pulmonary artery segment are prominent, whereas the aortic knob may appear unusually small.

5. Large defects with right-to-left shunt and severe pulmonary hypertension. The heart is usually small, without ventricular dilatation. The right ventricle is hypertrophied. The aorta is small, but the main pulmonary artery is extremely prominent. The hilar vascular markings are accentuated but markedly narrowed in the mid and peripheral portions of the lungs. The left atrium is not enlarged. An occasional case may show an essentially normal radiographic appearance.

Radiographic features of large ventricular septal defects in infants are usually not characteristic.

Venous angiography is not helpful in establishing a diagnosis of ventricular septal defects. Of more value, particularly in differentiating ventricular septal defects from extracardiac shunts, is retrograde aortography.

Twenty-one roentgenograms.
HANS A. LINDT, M.D.
Cleveland Metropolitan General Hospital

**Atrial Septal Defect: Experiences in the Clinical Evaluation of 15 Consecutive Cases of the Secundum Variety.** Bernard Zylberberg, Irving Kass, and Murray S. Hoffman. Am. J. M. Sc. **238:** 573–582, November 1959. (National Jewish Hospital, Denver, Colo.)

The authors report variations from the classical findings in a series of 15 consecutive cases of atrial septal defect of the secundum type. There was poor correlation between size of the defect as noted at surgery, degree of shunt, and clinical symptomatology. Three patients with pulmonary to systemic flow ratios

of 2:1 or greater, failed to demonstrate the mid-diastolic flow murmur which has been described as so characteristic. Only 5 of the 15 patients showed the typical roentgen findings of right heart enlargement, main pulmonary artery prominence, and increased peripheral vascularity. [A breakdown of the x-ray findings in individual cases is not included.] Several of the patients showed variants of the typical electrocardiographic findings.

Four roentgenograms; 17 electrocardiograms; 1 table.

RICHARD H. GREENSPAN, M.D.
New Haven, Conn.

**The Roentgen Diagnosis of Mitral Stenosis.** I. E. Kirsh and J. F. Kinney. Arch. Surg. **79:** 785–790, November 1959. (VA Hospital, Hines, Ill.)

The authors use radiography, fluoroscopy, and laminagraphy for the diagnosis of mitral disease. They seek to demonstrate specific heart chamber enlargement, and in this connection find displacement of the barium-filled esophagus to be the most important x-ray finding. The left lateral film is usually the most valuable one for this purpose. If the mitral valve is mainly stenotic, the left atrium is enlarged, displacing the esophagus posteriorly, well above the diaphragm. If there is mitral insufficiency, the left atrium and left ventricle are both large and the esophagus is displaced posteriorly all the way down to the diaphragm.

Hemosiderosis and disseminated bone nodules can sometimes be found in patients with mitral disease. Transverse septal lines (Kerley's B lines) are short, very thin, transverse lines seen in the costophrenic angles but sometime extending upward along the axillary line. They are thought to be thickened interlobular septa and frequently persist after mitral surgery.

Five tables appended to this paper present the authors' observations concisely. One of these is reproduced here.

COMPARISON OF MITRAL STENOSIS AND INSUFFICIENCY

A. Mitral stenosis.
   1. Enlarged left atrium
   2. *No* significant enlargement of left ventricle
   3. Enlarged right ventricle
B. Mitral insufficiency
   1. Enlarged left atrium
   2. Enlarged left ventricle
   3. Enlarged right ventricle
C. May be present in either mitral stenosis or insufficiency
   1. Calcification of mitral valve
   2. Disseminated bone nodules in lungs
   3. Pulmonary hemosiderosis
   4. Septal lines at bases of lungs (Kerley)

Seventeen roentgenograms; 2 photomicrographs.

HANS A. LINDT, M.D.
Cleveland Metropolitan General Hospital

**Occlusive Disease of the Carotid Artery. Observations on the Prognosis and Surgical Treatment.** Alfred J. Luessenhop. J. Neurosurg. **16:** 705–730, November 1959. (1150 Connecticut Ave., Washington 6, D. C.)

For this "special article," 486 cases of proved carotid occlusion, all but 22 collected from the literature, are reviewed. These cases tended to fall into two main categories: (1) those in which the neurological symptoms appeared during the vicissitudes of everyday life, hereafter referred to as spontaneous occlusion, and (2) those in which the neurological symptoms appeared immediately after or concomitant with surgical conditions or medical diseases, hereafter referred to as complication occlusion.

*Spontaneous occlusion* occurred in 384 cases. The onset was rapid and severe in 108 cases, gradual or spasmodic in 96, and intermittent in 82. In 98 cases there were associated symptoms (headaches, amaurosis fugax, bruit, syncope, psychic change). Males outnumbered females about 6 to 1. There was a high incidence of spontaneous occlusion among the young and middle-aged. The left side was involved about 2.5 times more frequently than the right.

There were 83 cases of *complication occlusion:* In 41 patients, neurologic symptoms developed immediately following or concomitant with surgical conditions—closed head injuries, penetrating and nonpenetrating cervical trauma, basilar fractures, cervical sepsis, pneumoencephalography, percutaneous angiography, surgery of the neck, surgical shock, intracranial aneurysms, a sphenoidal ridge meningioma, and a cervical rib. The medical illnesses associated with initial symptoms were influenza, pneumonia, septicemia, typhoid fever, rheumatic heart disease, diabetic coma, scarlet fever, meningitis, auricular fibrillation, and coronary thrombosis. In both the surgical and medical cases, the hemiplegias in general appeared rapidly; though in some cases they developed gradually over a few days.

The sudden—spontaneous—onset group and the complication group were comparable with respect to a low incidence of progression or appearance of intermittent signs.

In 212 cases the diagnosis was made angiographically. During the first month following onset of symptoms, 21 per cent of the occlusions were found in the region of the siphon, but with time this percentage decreased and became close to zero by thirty months.

In 41 cases bilateral arteriography was performed. A good cross-filling from the opposite side is the only finding that appears to offer some promise of a temporarily favorable prognosis.

In 79 cases the pneumoencephalographic description was adequate for appraisal. Correlation between symmetrical or asymmetrical ventricular enlargement and duration of the clinical findings was only fair. Of interest is the absence of ventricular enlargement for as long as two or three years after onset of symptoms. The finding of symmetrical dilatation with unilateral signs is consistent with the postmortem observation of rather diffuse and symmetrical foci of ischemic change. In cases of acute severe infarction a shift in the ventricular system to the opposite side has been described.

Seventy-three patients in whom complications developed following surgical occlusion served as controls. It was conjectured that the reciprocal of the time-incidence curve for these complications was a rough measure of the average rate of collateral development. The paucity of repetitious or progressive complications suggests an adequate period for collateral development rather than an exhaustion of collateral reserve as the cause for ischemia. Similarities between the control group and the sudden-onset and complications groups are evidence that this mechanism is important here also. The benefit derived from prompt

re-establishment of patency in the surgical group indicates that the most surgery can offer under ideal circumstances is a somewhat greater chance of complete recovery. The apparent surgical successes have been restricted to patients exhibiting signs of collateral exhaustion; there the limiting factor has been the inability to re-establish patency. It is estimated that success may be achieved in roughly 10 per cent; this figure may be improved by earlier diagnosis, increasing the possibility of finding only partial occlusion.

In an Addendum the author calls attention to the use of panangiography in the study of carotid occlusion by Crawford and De Bakey (Heart Bull. **8**: 8, 1959), which permits a more nearly complete evaluation of the per-Willisian vasculature. Confinement of angiography to portions of the cervical carotids may, in many cases, present an inadequate appraisal of the problem. The not uncommon observation of a normal cervical arteriogram immediately following cerebral infarction may find an answer here.

A bibliography of 332 references.

**Angiographic Demonstration of a Tumor Thrombus in the Popliteal Vein. Report of a Case.** C. Lagergren, Å. Lindbom, and G. Söderberg. Acta radiol. **52**: 401–405, November 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

The authors report a case of a tumor thrombus growing into the popliteal vein which was demonstrated angiographically. The tumor was a fibrosarcoma. Angiography was performed with 66 per cent Urografin and serial filming at approximately two-second intervals. Films showed a dense conglomeration of irregular vessels within the tumor and a fine network of thin, irregularly oriented vessels in the soft parts 5 to 15 cm. cranial to the tumor and dorsal to and closely related to the popliteal artery. Tissue in the region behind the popliteal artery and cranial to the tumor was diffusely opaque in the second film of the series. Contrast medium was shunted rapidly through tumor vessels into the veins, and in the third film many veins were seen in the popliteal fossa. The popliteal vein itself was not filled in the region between the tumor and a point approximately 10 cm. cranial to the upper end of the tibia.

In conclusion the authors state: "Contrast filling of many fine pathological vessels in the poorly differentiated tissue of the tumor thrombus produced diffuse opacity of this thombus in an early film of the serial angiography. The marked shunt through the tumor caused the veins in the region to be filled to such an extent that the tumor thrombus itself was seen in subsequent films as a filling defect in the popliteal vein. The previous hypervascularization at the site of this filling defect suggested that the thrombus consisted of neoplastic tissue."

Three roentgenograms; 2 photomicrographs; 1 microarteriogram. THEODORE E. KEATS, M.D.
University of Missouri

**A Safe and Practical Intravenous Method for Abdominal Aortography, Peripheral Arteriography, and Cerebral Angiography.** Israel Steinberg, Nathaniel Finby, and John A. Evans. Am. J. Roentgenol. **82**: 758–772, November 1959. (New York Hospital-Cornell Medical Center, New York 21, N. Y.)

The intravenous method of abdominal aortography, peripheral arteriography, and cerebral angiography, described here depends upon the principles developed for angiocardiography. Rapidity of injection of the contrast material is essential and can be accomplished by simultaneous injection into the large veins of both arms. Speed is also facilitated by elevating the arms and having the patient perform respiratory maneuvers.

The starting time of exposure for the aortogram or peripheral arteriogram is determined by establishment of the preliminary circulation time with Decholin. No special roentgenographic equipment is required. The exposure for abdominal aortography is prolonged to two or three seconds and begins about one-half second after the arm-to-tongue circulation time as previously determined. If peripheral arteriography is desired, another exposure may be made either with a portable roentgen apparatus or with another tube.

The first successful abdominal aortogram, with rapid, bilateral, simultaneous intravenous injection of concentrated contrast material and prediction of abdominal opacification was obtained in March 1959. Twelve additional patients have since been studied and in each instance the abdominal aorta and its branches were visualized. Illustrative films are reproduced. Eleven patients had mild transient reactions; moderately severe reactions were encountered twice. A contrast material dosage chart based on patient weight is included and strict adherence to this is advised for the avoidance of serious reactions. If dosage does not exceed 1 c.c. per kilogram of body weight, good tolerance is to be expected.

More studies are needed to test thoroughly the validity of the method of intravenous abdominal aortography, peripheral arteriography, and cerebral angiography here described, but the successes obtained to date and the sound principles tested during a twenty-year experience with angiocardiography make it certain that the procedure will prove a valuable one.

An Addendum brings the authors' series of cases to 52, in all of which the abdominal aorta and peripheral arterial circulation were visualized.

Eighteen roentgenograms; 3 photographs; 1 table.
JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

**Coronary Arteriography During Induced Cardiac Arrest and Aortic Occlusion.** Charles T. Dotter, Louis H. Frische, William S. Hoskinson, Etsuko Kawashima, and Ronald W. Phillips. Arch. Int. Med. **104**: 720–729, November 1959. (3181 S. W. Sam Jackson Park Rd., Portland 1, Ore.)

The authors believe that the combination of acetylcholine-induced cardiac arrest and total aortic occlusion represents a near-ideal approach to the problem of achieving anatomically detailed, apparently safe visualization of the coronary vessels in the intact human subject. Their technic for this procedure is described.

With the aid of an image-amplifying fluoroscope, the Dotter-Lukas catheter is passed retrogradely through the right brachial artery and maneuvered until its tip lies in the aorta approximately an inch above the level of the aortic valve. Arrangements are made for serial radiography in the desired projection, and a continuous oscilloscopic display of the electrocardiogram is instituted. General anesthesia is used, and personnel and equipment are available for emergency thoracotomy for cardiac resuscitation.

With the x-ray technician alerted, 5 mg. of acetylcholine in 20 c.c. of saline is rapidly injected into the lumen leading to the tip of the catheter. Cardiac arrest occurs almost immediately, whereupon the balloon is inflated by rapidly injecting 30 to 40 c.c. of nitrous oxide or carbon dioxide into the second lumen of the catheter. As soon as the balloon has been inflated, the desired dose of contrast substance is injected as rapidly as possible into the now isolated proximal aorta. Starting with the beginning of injection, serial radiographic exposures are made, usually at one-second intervals. At this rate, it is generally possible to obtain films until after ventricular contractions reappear. This is desirable if the myocardium and coronary venous circulation are to be visualized. A second or two after completion of the injection the balloon is allowed to deflate, although no harm would result if this were delayed until the time of reappearance of the heart beat. Once normal sinus rhythm is reestablished, the catheter is removed and the artery repaired.

Colloidal thorium dioxide (Thorotrast) has been found to be the contrast medium of choice for coronary arteriography. Its advantages are thought to outweigh theoretical objections to its weak radioactivity. Since a catheter is used for the injection, tissue reaction does not constitute a hazard.

Acetylcholine-induced arrest was employed as an adjunct to coronary angiography with aortic occlusion in over 70 experiments. Induced arrest greatly simplifies the procedure by eliminating the mechanical effects of left ventricular contraction upon the position of the occluding balloon. The induction of arrest just prior to the institution of aortic occlusion results in an impressive improvement in the quality of visualization and the ease and regularity of its attainment.

The controlled production of selective vascular occlusion has also been employed in the study of the aortic branches. Balloon catheter occlusion at appropriate sites offers a means for altering the direction of congenital cardiovascular shunts and thereby provides a method for establishing with certainty the diagnosis of lesions previously refractory to visualization by ordinary technics.

Although acetylcholine had produced no untoward effects in several hundred dog studies and a number of arrests in man, a fatality occurring shortly after submission of this paper has caused modification in the approach to induced cardiac arrest. The patient was a 66-year-old man who had recently been in congestive heart failure and was fully digitalized at the time of attempted coronary arteriography. Two separate injections of acetylcholine were accompanied by myocardial irritability, followed by irreversible ventricular fibrillation and death. This experience confirms experimental evidence that the combination of digitalis and acetylcholine tends to produce ventricular irritability rather than asystole. Consequently, acetylcholine-induced arrest should not be used in digitalized patients.

Nineteen roentgenograms; 2 blood pressure tracings.

**Cause of Death in Cardioangiography.** Raymond C. Read. J. Thoracic & Cardiovas. Surg. **38**: 685–695, November 1959. (VA Hospital, Minneapolis, Minn.)

The mortality of intravenous pyelography has been reported by Pendergrass, *et al.* (Am. J. Roentgenol. **74**: 202, 1955. Abst. in Radiology **66**: 919, 1956) to be less than 1:150,000, whereas that associated with cardioangiography is ten thousand times greater, or an appreciable 2 to 5 per cent (Dimond and Gonlubol: New England J. Med. **249**: 1029, 1593. Abst. in Radiology **63**: 597, 1954). This difference has been assumed to be a reflection of the greater risk in the patient with cardiac disease, coupled with the fact that x-ray visualization of the heart requires an increased rate of injection as well as a more concentrated organic iodine preparation. The author has carried out an investigation to determine the mechanism responsible for these fatalities. In his experiments, 1 to 3 ml. of various concentrated radiopaque agents, per kilogram of body weight, was rapidly injected into the venous system of 24 dogs. Experiments were of three types: open chest (44 injections in 16 dogs); perfusion of the isolated lung (16 lungs); and total-body perfusion (8 experiments).

The results of the investigation demonstrate unequivocally that radiopaque preparations lower peripheral resistance. This finding, combined with the pulse pressure, pulse wave, plethysmographic, skin temperature, and microscopic changes reported by others, confirms the vasodilatory nature of these compounds shared with other hypertonic solutions. This effect is delayed after intravenous injection because it depends upon direct contact with the peripheral vasculature. The elevation in pulmonary artery pressure, venous pressure, and heart rate observed at this time suggests a compensatory adrenergic release. This relatively benign peripheral phenomenon, perhaps of importance only in hypertensive and arteriosclerotic disease, is preceded by the possibility of a potentially much more dangerous reaction—obstruction to blood flow through the lungs. All of the dogs who succumbed did so as a result of acute cor pulmonale. Circumstantial evidence obtained from case reports on patients who died suggests a similar cause of death.

The present study also shows that doses up to 1 ml. per kilogram give rise to detectable changes in blood viscosity only when the osmotic activity of the solution is greater than 1,500 mOsm. per liter. Larger volumes tend to lower this threshold. The central effect requires a much stronger solution than the vasodilatation seen in the peripheral vasculature.

Studies of the isolated perfused lung show that the increase in pulmonary vascular resistance is related to the presence of red cells in the perfusate. The phenomenon of red cell agglutination explains a number of hitherto poorly understood clinical observations. Complications have increased sixfold since 35 per cent solutions have been replaced by 70 per cent preparations. This risk of agglutination could be markedly reduced, if not eliminated, by changes in the characteristics of the more concentrated preparations. An attempt should be made to limit their osmotic activity to less than 1,500 mOsm. per liter by either decreasing their solubility or increasing their molecular size.

Six figures; 1 table.

## THE DIGESTIVE SYSTEM

**Benign Gastric Neoplasms.** A. R. Watson, T. R. Sunbury, and Terrell Speed. Texas State J. Med. **55**: 890–894, November 1959. (A. R. W., Orange Memorial Hospital Corporation, Orange, Texas)

The authors report their experiences in 19 proved cases of benign gastric neoplasm plus an additional 6

cases originally considered benign but subsequently found to be malignant. Previous studies have shown that only 1.3 per cent of all tumors removed from the stomach at surgery are benign. Of the authors' 19 cases, 11 occurred in women and 8 in men; 84 per cent of the patients were over fifty years old.

Indigestion and vomiting are the most common complaints. Sudden hematemesis or tarry stool and periodic vomiting often over a period of several months are points in the history suggesting a possible benign neoplasm. Physical findings generally are not helpful but in about one-fourth of the cases reported here anemia was present. Findings at radiologic examination are generally similar to those described by others as indicative of benign gastric disease. Two of the tumors in this series showed ulceration within the lesion, centrally located and superficial. All 19 cases, as well as the 6 which showed histologic malignant change, were diagnosed radiologically as probably benign. Gastroscopic examination was performed in a few instances and should be used in conjunction with radiologic study when indicated.

Three-fourths of the tumors were found in the antrum or mid-gastric body, three in the upper third of the stomach, and three in multiple sites. Of the benign lesions, 11 were adenomas, 6 were leiomyomas, 1 a lipoma, and 1 a neurofibroma. The 6 malignant tumors included 3 Grade I adenocarcinomas and 2 Grade I leiomyosarcomas. One patient had a typical benign adenoma within which was found a minute adenocarcinoma. The lesions are ordinarily best managed by surgical removal.

One roentgenogram; 1 photomicrograph; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**The Radiological Diagnosis of the Congenital Obstruction of the Duodenum (Megaduodenum).** C. B. A. J. Puylaert. J. belge de radiol. **42:** 569–581, 1959. (In English) (St. Elisabeth Hospital, Tilburg, The Netherlands)

Congenital obstruction of the duodenum may be due (1) to an intrinsic occlusion, total or subtotal, as a result of narrowing of the lumen or of a diaphragm, (2) to difficulty of transit similar to that in Hirschsprung's disease, (3) to an annular pancreas, or (4) to volvulus or kinking.

Vomiting occurs immediately after birth, the vomitus at times containing bile or blood. Without surgical intervention (gastroenterostomy), death occurs rapidly from disturbances of electrolyte balance and dehydration. Many of the patients are mongoloids.

The radiographic appearance is that of two air-bubbles connected by a narrow neck: the pyloric canal. The right bubble is usually rounder and more "intensive" than the left. Sometimes, as a result of peristalsis, only a single air bubble can be seen, so that more than one examination may be necessary.

After reviewing 12 personal cases and the literature, the author stresses the following points: All patients, even those with total atresia, still excrete meconium. The peristaltic wave in pyloric stenosis may produce a picture resembling the "double bubble." Absence of air in the intestines supports the diagnosis; its presence rules out only a total occlusion.

The author describes a new phenomenon observed in some cases of subtotal occlusion, namely a small barium-lined cap, adjacent to the stenosis. This resembles the duodenal bulb but shows circular "ribs" due to barium in the mucosal folds of the small collapsed poststenotic jejunal loop.

In many cases, the radiologist is able to make the diagnosis with more assurance than the surgeon.

Thirty-two roentgenograms; 1 table.

RENÉ HOURI, M.D.
New York, N.Y.

**Deformity of the Duodenal Bulb Caused by Atypical Localization of the Papilla of Vater.** K. Rosteck. Fortschr. a. d. Geb. d. Röntgenstrahlen **91:** 609–612, November 1959. (In German) (Harrlallee 2, Bad Eilsen, Germany)

Numerous variations and anomalies of the cystic and common duct have long been known, and introduction of Biligrafin has greatly facilitated their recognition. Displacement of the papilla of Vater into the duodenal bulb is, however, quite rare. The author describes 2 cases of this anomaly in detail.

The first patient was a 20-year-old man who had had eight gastrointestinal x-ray examinations, each of which demonstrated a deformed duodenal bulb with a barium spot the size of a pea in its posterior wall. Surgical exploration showed various adhesions in the duodenal area and an anomalous course of the common duct, ending with the papilla of Vater in the posterior wall of the bulb. No ulcer was found. A check-up gastrointestinal x-ray examination with simultaneous visualization of the bile ducts by means of Biligrafin confirmed the surgical diagnosis.

The second patient, a man of 47 years, gave a history of stomach disturbances for five years. X-ray examination showed a deformed duodenal bulb with a constant barium spot in the posterior wall. Surgical exploration revealed dense adhesions between the gallbladder and the duodenum. The gallbladder was removed (pathological report: chronic fibrotic cholecystitis with foreign body granulomata) and cholangiography was done during the operation, showing the papilla of Vater in the posterior wall of the duodenal bulb, where the barium spot had simulated an ulcer. No ulcer was found.

Five roentgenograms; 1 diagram.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

**Deficiency of Small Intestinal Gas in Infants Simulating Obstruction.** Herbert H. Benson and George Jacobson. Am. J. Roentgenol. **82:** 450–454, September 1959. (G. J., 1200 North State St., Los Angeles 33, Calif.)

Deficiency of gas in the small intestine of the newborn child or small infant is usually regarded as a cardinal sign of intestinal obstruction. Recently, however, Margulis *et al.* (Radiology **66:** 93, 1956) and Feinberg *et al.* (Pediatrics **18:** 790, 1956. Abst. in Radiology **69:** 455, 1957) have shown that the condition may be associated with adrenal insufficiency, dehydration, diarrhea, or interference with normal transport mechanisms.

In this article there are presented 4 cases in which absence or diminution of small-intestinal gas in infants simulated obstruction. Two patients in whom respiratory difficulty was the cause came to autopsy. Dehydration and diarrhea were present in the other 2; 1 of these was operated upon but no disease or abnormality was identified despite careful examination

of the small and large intestine from the ligament of Treitz to the rectum; in the other, roentgenography with Lipiodol disclosed no evidence of obstruction and an uneventful recovery followed the administration of hydration and antibiotics.

The use of oral contrast material appears to be a safe procedure in suspected obstruction of the small intestine. In infants, however, the authors prefer not to use barium. Patency of the intestinal lumen can be determined without difficulty with the use of oily or water-soluble media. The water-soluble media have an additional advantage: namely, hypertonicity, which results in rapid passage through the small intestine, facilitating early diagnosis. There is little or no absorption from the gastrointestinal tract and no toxic symptoms have been observed.

Six roentgenograms.

**Jejunal Diverticula.** Enrique de Arzua Zulaica. Arch. d. mal. de l'app. digest. **48:** 1442–1446, November 1959. (In French) (Bilbao, Spain)

The author reviews briefly the literature on jejunal diverticula and mentions the association of macrocytic and megaloblastic anemia which has recently been stressed.

Jejunal diverticula are difficult to detect even at autopsy, though they are found seven times more frequently postmortem than following radiological examination. They are located mostly in the upper jejunum, and are of two types: true diverticula formed by mucosa, tunica muscularis, and serosa, often associated with other diverticula of the digestive tract; false diverticula formed only of mucosa and serosa. Both types occur in persons of fifty to sixty years of age and are slightly more common in the male.

Clinical symptoms, when present, consist mainly of slight abdominal pain, meteorism, and borborygmi. Inflammation, hemorrhage, perforation, occlusion, and invagination are the most common complications. In the subacute case, a pseudotumoral picture may be present because of involvement of neighboring mesenteric lymph nodes.

The upright position is the best for radiologic examination. Visualization may be rather difficult because of the location and the width of the neck of the diverticulum. The characteristic picture is that of a "pigeon nest," with fluid level. The location varies with positioning and intestinal peristalsis.

Three roentgenograms. PETER TORBEY, M.D.
University of Missouri

**Roentgenologic Aspects of Hydrostatic Reduction of Ileocolic Intussusception.** Bertram R. Girdany, Lee W. Bass, and William K. Sieber. Am. J. Roentgenol. **82:** 455–461, September 1959. (Children's Hospital of Pittsburgh, Pittsburgh 13, Penna.)

After a review of the technic of hydrostatic pressure reduction of intussusception by barium enema, the authors report their results with this procedure as the initial treatment in 106 cases.

In 87 instances of uncomplicated ileocolic intussusception the treatment was definitive; there were 5 failures in uncomplicated cases. Two children were found at surgery to have gangrenous bowel which required resection. The single death in this series occurred two days after hydrostatic reduction of the intussusception: the infant was moribund on admission and hydrostatic pressure was used at the request of the attending surgeon because it seemed improbable that laparotomy would be tolerated. Necropsy showed complete reduction of nongangrenous bowel.

Hydrostatic treatment was undertaken in 11 children with ileo-ileal intussusception, in 8 of whom plain roentgenographic films showed intestinal obstruction. In 4 patients the hydrostatic pressure failed to provide reflux of opaque medium into the ileum; 3 had lead points roentgenographically identified as filling defects in the barium column in the ileum; 4 showed characteristic signs of ileo-ileal intussusception; in 1 infant there was complete reduction of the intussusception by hydrostatic means.

It is concluded that the presence of ileo-ileal intussuception or gangrene is suggested by failure of successful reduction by hydrostatic pressure, as well as by plain roentgenographic findings of intestinal obstruction. Such x-ray findings contraindicate the use of the procedure.

Ten roentgenograms; 1 photograph.

**Asymptomatic Tuberculous Enteritis Simulating Carcinoma of the Cecum.** Hubert U. Waggener, James P. Muldoon, and J. Richard Heaton. J.A.M.A. **171:** 1337–1338, Nov. 7, 1959. (H.U.W., 3710 E. Fifth Ave., Denver 6, Colo.)

A 38-year-old man entered the hospital because of a local discharge from "near the rectum" of three months duration. He had no other complaints. Local examination of the perianal area showed a 2.5-cm. linear ulceration with overhanging edges. A barium enema examination disclosed a filling defect in the mid part of the ascending colon, suggestive of a neoplasm. At laparotomy a large, firm, constricting, and irregular lesion of the ileocecal area was found, with multiple adherent loops of distal ileum and large firm lymph nodes throughout the adjacent mesentery. Gross appearance at surgery strongly suggested adenocarcinoma, and an extensive right hemicolectomy was performed. Later histologic study revealed typical multiple tuberculoid areas with groups of Langhans-type giant cells. Biopsy of the anal ulcer showed a chronic nonspecific inflammatory reaction; special stains demonstrated probable acid-fast organisms. Subsequent studies for tubercle bacilli in the sputum and gastric content were positive. Conventional chest roentgenograms showed fibrocalcific and fibrotic markings in the right apex felt to represent an old acid-fast infection, inactive or healed.

The authors comment that "it is rare to see a patient with active pulmonary tuberculosis and extensive tuberculosis of the ileocecal region without symptoms or suggestive findings physically." Tuberculous enteritis is usually associated with advanced active pulmonary tuberculosis with prominent symptoms, all absent in this case.

Two roentgenograms: 1 photomicrograph.
JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Radiological Detection of Meckel's Diverticulum.** Benjamin Edye, K. B. Voss, and E. G. H. Manchester. M. J. Australia **2:** 765–766, Nov. 21, 1959. (Sydney, N. S. W., Australia)

The authors report the case of a 56-year-old man who complained of persistent pain radiating down the right side of the abdomen. Attacks sometimes lasted for twenty-four hours, during which time he felt very

sick and wanted to vomit. He had suffered three attacks within the four weeks prior to admission.

The physical examination was noncontributory. An upper gastrointestinal series showed no abnormality in the stomach or duodenum and twenty-four hours after ingestion of a barium meal the large bowel appeared normal. Just above the sigmoid colon, however, where the density of the barium was not marked, there was seen to be an ovoid shadow of considerably greater density, not related to the colon or rectum. This was considered to be a diverticulum of the small bowel, almost certainly a Meckel's diverticulum. An opaque enema examination confirmed the normal appearance of the large bowel. A second opaque meal was given in an attempt to demonstrate the attachment to the ileum, but on this occasion the diverticulum did not fill. Operation revealed a Meckel's diverticulum about 6 inches long, arising about 4 feet from the cecum. The pathological report confirmed the diagnosis.

One roentgenogram; 1 photograph.

MUSTAFA BALKIR, M.D.
Cleveland Metropolitan General Hospital

**Appendicular Calculi.** M. F. Butler. Brit. J. Surg. **47:** 279–281, November 1959. (Westminster Hospital, London, S. W. 1, England)

A case of multiple appendicular calculi is reported. The preoperative diagnosis, based on the clinical and radiological findings, was right ureteral calculi, and the possibility of appendiceal stones was not entertained. At operation a perforated appendix was found, containing three calculi, stony hard and of a whitish color; they bore no resemblance to fecaliths and may be classified as true calculi.

The preoperative diagnosis of appendicular calculi rests on the correct interpretation of a shadow or shadows seen in a roentgenogram of the abdomen. In most of the recorded cases the stones were demonstrated for the first time during an attack of acute appendicitis. The attack is usually a severe one, and the incidence of perforation is high. In most of the cases which have been reported, the clinical features have been somewhat atypical of appendicitis. Delay in advising operation is more likely to occur in the clinically atypical case, and a calculus seen on the roentgenogram may be mistaken for some other condition, leading possibly to further delay. This happened in the author's case, and it is probable that, had the patient not had the "advantage" of an x-ray examination, the appendix would have been removed forty-eight hours earlier.

Fortunately the roentgen features of appendicular calculi are often sufficiently characteristic for the correct diagnosis at least to be suggested. The stones are more often single than multiple; if multiple, they may be faceted, as in the present case. The shadow(s) may be seen in any position that the appendix can occupy, most commonly the right iliac fossa or the right side of the pelvis. The most reliable single feature is peripheral lamination.

Two roentgenograms; 1 photograph.

**Diverticulum of the Gallbladder. A Report of Three Cases and a Review of the Literature.** Joseph P. Arcomano and James C. Barnett. Am. J. Digest. Dis. **4:** 556–562, July 1959. (North Shore Medical Group, Huntington, N. Y.)

Three new cases of congenital diverticulum of the gallbladder are presented, one surgically and histologically proved. All 3 cases presented what the authors believe to be sufficient evidence for roentgen diagnosis in that they showed the same relative contraction after a fatty meal as the remainder of the gallbladder. None of the various types of acquired diverticula show similar contraction after a fatty meal.

Six roentgenograms. WENDELL M. BURNS, M.D.
Covina, Calif.

**Choledochus Cyst.** R. V. Fiddian and Colin McDougall. Brit. J. Surg. **47:** 240–244, November 1959. (R.V.F., St. Bartholomew's Hospital, London, England)

Two cases of choledochus cyst are reported, in only 1 of which did a radiologic examination contribute to the diagnosis. The gallbladder failed to concentrate the contrast medium, but the hepatic flexure of the colon was outlined, showing it to be significantly depressed. This was associated with absence of gas shadows in the right upper abdomen. In retrospect, the latter sign was evident in a plain roentgenogram taken a month earlier, which had been reported as normal apart from hepatic enlargement. The most dramatic roentgen findings were obtained following a barium meal, which showed the duodenum displaced so far forward that it was compressed against the anterior abdominal wall and flattened to such an extent that barium collected only at the angles.

Five roentgenograms; 1 table.

**Choledochocolic Fistula. A Case Report.** Lawrence G. Hampson and Geoffrey Lehman. Arch. Surg. **79:** 746–749, November 1959. (Montreal General Hospital, Montreal, P. Q., Canada)

The most frequent of the internal fistulas due to biliary disease is the communication between the gallbladder and upper small bowel. Less commonly fistulas develop between the common bile duct and the duodenum. Communications between the biliary tract and colon are unusual. The authors found only 2 reports of choledochocolic fistula in the literature. They present a third case, preoperatively diagnosed by barium enema. In this instance the fistula was thought to have formed three years after a second operation for choledocholithiasis. It was felt to be due to erosion of a calculus into the colon.

Two roentgenograms. HANS A. LINDT, M.D.
Cleveland Metropolitan General Hospital

**X-Ray Diagnosis of Bile Duct Calculi.** E. Salzman, R. P. Spurck, and D. H. Watkins. Gastroenterology **37:** 587–594, November 1959. (E.S., Department of Health and Hospitals, Denver 4, Colo.)

Although 25 to 30 per cent of gallbladder stones can be visualized as calcific shadows on the plain film of the abdomen, the authors found only 2 of 100 bile duct stones containing sufficient calcium to be seen on roentgenograms. Such calculi are demonstrated by oral or intravenous cholangiography, appearing as radiolucent shadows in the column of contrast medium. Each of these methods has its proponents, but most authors prefer the intravenous study. Laminagraphy is useful as an aid in delineating small filling defects which may be overlaid by gas shadows on the routine films.

The authors used a third procedure, "biliary calculography," for the identification of opacifying gallstones in 120 cases, prolonging administration of an oral chole-

cystographic medium for several days. In 10 of 13 patients with proved bile duct stones, the calculi were demonstrated by administration of 3 grams of Telepaque per day for four days. The authors feel that this is probably the best method available for identifying bile duct stones in the presence of jaundice.

In a series of *in vitro* experiments it was determined that it is the bilverdin content of stones that is opacifying and that this substance must be located at the surface in order for opacification to occur.

Four roentgenograms; 3 photographs.

RICHARD H. GREENSPAN, M.D.
New Haven, Conn.

**Emphysematous Necrotizing Pancreatitis.** Murry G. Fischer and Abraham Geffen. Arch. Surg. **79:** 567–569, October 1959. (2 Fifth Ave., New York 11, N. Y.)

The authors report a case, believed to be the twenty-first in the literature, of acute necrotizing pancreatitis with gas formation.

Roentgen diagnosis of this condition is made in a patient with acute pancreatitis who demonstrates either unilocular or diffuse gas collections outside the intestinal tract and in the region of the pancreas. In the authors' case the gas was apparent on the roentgenogram in the form of many tiny bubbles distributed throughout the pancreas. The majority of the recently published cases have shown a similar picture, but earlier reports describe a large unilocular gas abscess, due possibly to late coalescence of an originally diffuse process.

Prognosis is poor. Of 13 patients with diffuse emphysematous necrosis, only 3 (or possibly 4) survived. With unilocular abscesses the survival rate was higher—at least 4 of 8 patients.

Two roentgenograms.

WENDELL M. BURNS, M.D.
Covina, Calif.

## THE MUSCULOSKELETAL SYSTEM

**The Value of Arteriography in the Diagnosis of Bone Tumours.** Basil Strickland. Brit. J. Radiol. **32:** 705–713, November 1959. (Westminster Hospital, London, S. W. 1, England)

Arteriograms were obtained in 40 cases of neoplasm of bone and soft tissues, 33 of which were primary bone tumors. Many of the patients were later subjected to amputation, and the limbs were injected and examined by body-section radiography.

Roentgenographic signs suggesting malignancy were found to include: abrupt termination of an otherwise normal artery in the neighborhood of a bone tumor; the presence of straight veins coursing at right angles to the normal flow of venous blood; a nest of small vessels encircling the periphery of an area of relative avascularity; pooling of contrast medium in areas of necrotic tumor tissue; and the presence of "pathological vessels," which are described as deployed seemingly without purpose, keeping no set course, showing no progressive diminution in caliber, and often terminating in amorphous tumor lakes.

In truly benign bone tumor there is usually only mechanical displacement of vessels by the mass. Diffuse staining of the neoplasm by contrast medium may be seen whether the process is benign or malignant.

The author did not feel that arteriography could be used as a dependable guide to tumor response in x-ray therapy. However, he felt that it should be routine prior to irradiation as a means of defining the limits of growth. He was not able to differentiate primary from metastatic bone tumors by arteriography, nor to distinguish between types of primary tumors.

Eighteen roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Arteriography of Bone Tumors and of the Soft Parts of the Extremities.** S. Chiappa, G. Di Muro, and G. P. Garavaglia. J. de radiol. **40:** 639–655, November 1959. (In French) (Institut du cancer de Milan, Milan, Italy)

The authors systematically used arteriography in all the cases of tumor of the extremities seen in the course of a year. Their aim was to throw light on the problem of the existence of differential characteristics in the vascular supply of various types of neoplasm in order to be able to differentiate between a malignant and a benign lesion.

It is concluded that arteriography should be included among the usual investigations for the following reasons: If correctly performed, it is easy and without incident. It can reveal tumors that are difficult to detect by simple roentgenography. This is especially true for tumors of the soft parts without bone involvement. It makes possible determination of the limits of those tumors that involve the bones quite minutely. It reveals the dimensions of tumors involving the bones widely, showing invasion of the para-osseous soft parts, which is not always sufficiently clear on the plain film.

Forty-nine roentgenograms. RENÉ HOURI, M.D.
New York, N. Y.

**Unusual Roentgen Manifestations of Osteomalacia.** Howard L. Steinbach, Felix O. Kolb, and Jackson T. Crane. Am. J. Roentgenol. **82:** 875–886, November 1959. (University of California Medical Center, San Francisco 22, Calif.)

Osteomalacia is characterized by a failure of deposition of calcium salts in osteoid tissue. It may result from impaired intestinal absorption of calcium or phosphorus, from increased renal excretion of those substances, or from a decrease of alkaline phosphatase activity.

Roentgenographically, well advanced cases show a generalized decrease in bone density, and there may be bending or fracture of bones due to skeletal weakening. Pseudofractures, radiolucent bands of decreased density in the bone cortex, are sometimes seen.

The authors present 3 cases, in members of a single family, due to excessive urinary phosphate excretion. The patients' bones were thick and rather dense. The usual prominences were exaggerated and irregular. Cancellous bone was overabundant, and the cortex appeared less compact and homogeneous than normal. Numerous small extra-ossification centers were present about many of the joints. Clinically, the 2 adult patients resembled achondroplastic dwarfs. The 1 child showed typical radiographic abnormalities of rickets. Two of the patients had premature closure of the sagittal suture of the skull.

Irregular endochondral ossification at the ends of the long bones and stresses applied by ligaments and

tendons to the weakened bone were felt to be responsible for the observed changes.

A fourth case of osteomalacia, due to chronic pancreatitis, is reported. This patient showed signs of hyperparathyroidism which was evidently secondary, as the parathyroids were found at autopsy to be normal. The entire skeleton was markedly decalcified, pseudofractures were present in the distal thirds of the clavicles, bases of the acromion processes of scapulae, posterior and lateral surfaces of the ulnae, and the superior and inferior pubic rami. There also were subperiosteal cortical erosion, absence of lamina dura of the jaws, localized destructive lesions, mottling of the calvaria, and calcification within the body and tail of the pancreas.

Nineteen roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Acute Leukemia. Skeletal Manifestations in Children and Adults.** Theodore F. Hilbish, Byron E. Besse, Jr., Lee B. Lusted, Marvin L. Daves, Louis B. Thomas, and Claude A. Forkner. Arch. Int. Med. **104**: 741–747, November 1959. (T. F. H., 2 West Drive, Bethesda, Md.)

The material contained in this paper was presented as an exhibit in the Section of Radiology at the Annual Meeting of the American Medical Association. It demonstrates the bony changes resulting from acute leukemia, with direct correlation between roentgen findings and the histologic abnormalities. In adults the primary lesions are those of osteoporosis and lytic destruction of the cortices and medullary cavities. In children the most conspicuous changes occur in the metaphyses of the long bones and consist of radiolucent bands of decreased density associated, at times, with areas of bony destruction. Cortical thinning, periosteal new bone formation, infiltration, and hemorrhage, as well as lytic lesions of the medullary cavities and cortices, are observed. Growth lines are often seen in the roentgenograms of those patients experiencing periods of remission following antileukemic therapy.

The radiolucent bands at the metaphyses and along the borders of vertebral bodies have been attributed to leukemic infiltration. The exact explanation for these zones of decreased density is not apparent from the authors' study.

Acute bone infarcts are seen microscopically in bones of both children and adults. During the acute stage, no roentgen abnormalities are demonstrable. Following necrosis, however, lytic areas of destruction are observed roentgenologically. Subperiosteal leukemic infiltration and hemorrhage stimulate new bone formation, and these changes are seen most frequently along the metaphyses. While the roentgen findings in general are predominantly those of osteoporosis, on rare occasions an osteoblastic reaction occurs, with osteosclerosis due to excessive formation of bony trabeculae.

Three cases are reported briefly.

Twenty-six figures, including 17 roentgenograms.

**The Bone Changes in Sickle Cell Anaemia and Its Genetic Variants.** J. S. R. Golding, J. E. MacIver, and L. N. Went. J. Bone & Joint Surg. **41-B**: 711–718, November 1959. (University College Hospital of the West Indies, Mona, St. Andrew, Jamaica)

In sickle-cell anemia the greater part of the hemoglobin is of an abnormal type (S). When less than half the hemoglobin is of this type, there results the milder sickle-cell trait, usually without symptoms. When hemoglobin C is present, reacting with S, we have the so-called sickle-cell hemoglobin C disease. Still another variant is sickle-cell thalassemia disease.

This report describes the bone findings in 51 cases of sickle-cell anemia, in 19 cases of sickle-cell hemoglobin C disease, and in 2 cases of sickle-cell thalassemia disease. The osseous changes fall into 4 major groups; those due to bone hyperplasia, thrombosis and infarction, growth effects, and infection.

*Bone changes due to marrow hyperplasia* are seen only in sickle-cell anemia and were present in 36 of the 51 cases. The erythroid hyperplasia affects the bone trabeculae, causing absorption, osteoporosis, softening, and change in bone shape. Vertebral bodies, especially in the lower lumbar region, are reduced in height and the disks bulge into the bodies. In the skull, a loss of trabecular definition gives a ground-glass appearance. In the long bones, the cortex becomes thin on its inner surface as the medulla hypertrophies. In the flat bones, particularly the ribs, there is a widening of the trabecular pattern, with osteoporosis, cortical thickening, and sometimes patchy sclerosis or erosion if infarction has supervened.

*Avascular necrosis of the epiphyses* is said to arise from thrombosis and infarction. This may occasionally cause collapse of a vertebral body but the femoral head is most often affected, particularly in the variants of sickle-cell anemia. The changes resemble Perthes' disease clinically but often occur in older patients. The metaphyseal changes are not well marked. Thirteen of 19 cases of sickle-cell hemoglobin C disease showed avascular necrosis of the femoral head epiphyses. This occurs just before the epiphyses have fused. The outer third of the head may be spared. The adult type of avascular necrosis may be present. Avascular necrosis was also seen in 5 of the 51 cases of sickle-cell anemia and in 1 of the 2 cases of sickle-cell thalassemia. It may be found in other regions, such as the head of the humerus.

Chronic anemia may cause *retardation of growth*. In this series this did not occur to any significant degree in the sickle-cell variants but 48 out of 51 patients with sickle-cell anemia were below average size.

In a crisis, an affected bone may become hot and swollen and *infection* may supervene. This occurred in 7 of the 51 cases of sickle-cell anemia and in 1 of the 2 cases of sickle-cell thalassemia. The infection seems to be of low grade. Salmonella is a common infecting agent.

Six figures, including 5 roentgenograms; 4 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N.Y.

**Traumatic Multiple Hyperostosis of Bone.** C. C de Silva and Susantha Jayaratne. Arch. Pediat. **76**: 447–449, November 1959. (University of Ceylon, Colombo, Ceylon)

A male child about eleven months old was hospitalized with a two-month history of swelling and tenderness of the limbs. Delivery had been normal and the past history was noncontributory. Physical findings were confined mostly to the limbs, where slightly tender transitory swellings developed, without evidence of inflammation. Laboratory studies were generally normal except for some increase in alkaline

phosphatase. Radiographs showed marked hyperostosis of both humeri and the right tibia, associated with irregularity of metaphyses of these bones. Healing fractures were observed in the right thorax, involving multiple ribs, with callus formation. The child died of bronchopneumonia eight weeks after admission. At autopsy, normal bone containing cystic spaces was obtained.

The findings on the films tend to mimic infantile cortical hyperostosis, except that in that condition the metaphyses are never involved. Other causes of cortical hyperostosis were considered ruled out by the history and laboratory findings. Direct questioning could not elicit any history of trauma. The authors conclude, however, that "x-rays may be the only means of diagnosing the traumatic origin of such lesions and, if the x-ray evidence is sufficiently convincing, this diagnosis must be made even in the complete absence of a history of trauma."

Three roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**The Relationship of Iodine Metabolism and Bone Structure in Endemic Cretinism.** M. P. König and P. Veraguth. Radiol. clin. **28:** 367–374, November 1959. (In German) (Röntgeninstitut des Inselspitals Bern, Bern, Switzerland)

In 12 endemic cretins the bone structure as exhibited in roentgenograms was compared to iodine metabolism studies. One group, consisting predominantly of male cretins, revealed the plump "classical" skeletal picture with short metacarpals and flattened femoral heads associated with hypothyroid iodine tracer and protein-bound iodine studies. The other group, predominantly female, revealed a more slender type of skeleton with less flattening of the femoral heads, normal iodine uptake, normal protein-bound iodine, and a higher conversion rate.

Eight figures, including 4 roentgenograms.
CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

**Infantile Structural Scoliosis.** J. I. P. James, G. C. Lloyd-Roberts, and M. F. Pilcher. J. Bone & Joint Surg. **41-B:** 719–735, November 1959. (J. I. P. J., Royal Infirmary, Edinburgh, Scotland)

Since 1951 (See James: J. Bone & Joint Surg. **33-B:** 399, 1951. Abst. in Radiology **59**: 141, 1952), it has been apparent that there are two types of infantile structural scoliosis, progressive and resolving. The former develops rapidly and relentlessly, causing the severest kind of orthopedic crippling, with dreadful deformity, marked dwarfing, and decreased longevity. The resolving type is at first essentially the same, but disappears spontaneously in the first few years of life. To confirm the diagnosis of infantile idiopathic scoliosis it is essential that congenital anomalies be excluded either at operation or by early roentgenograms before distortion and deformity make the distinction impossible.

While there is no absolute distinction between the two types of curvature, one can often prognosticate correctly. The typical resolving curve is single and always without compensatory curves, whereas only 7 progressive curves with no compensation were initially observed by the authors. The presence of compensatory curves seems to be an absolute indication of permanency. It has been suggested that the resolving curve is usually longer than the progressive, but although the longest curve encountered by the authors was resolving, so was the shortest. In summary, long curves of less than 35° and without compensation will probably resolve, but it must be emphasized that the distinction is not absolute and there is much to suggest that initially the two types are identical.

Of 212 cases of infantile structural scoliosis studied by the authors, 77 were of the resolving type and 135 of the progressive type. In the latter group, there were 111 thoracic curves, 13 double primary curves, 8 thoracolumbar curves, and 3 lumbar curves.

Thirty-six roentgenograms, and in some instances photographs, dramatically illustrate the two types of infantile structural scoliosis.

**A Contribution to the Congenital Fusion of Cervical Vertebrae and to Fatigue Fracture of the Spinous Processes of the Cervical Spine.** H. Reinhold and R. Sauerbrey. Fortschr. a. d. Geb. d. Röntgenstrahlen **91:** 643–648, November 1959. (In German) (Strahleninstitut, Lüneburger Str. 4, Magdeburg, Germany)

The authors have surveyed 4,071 x-ray films of the cervical spine in order to evaluate congenital fusion of the cervical vertebrae (Klippel-Feil syndrome) and fatigue fractures of the spinous processes.

Acquired fusion is usually due to infectious processes (tuberculosis, osteomyelitis, typhoid), injury, or degeneration and atrophy of the disk spaces. The differential diagnosis between acquired and congenital fusion is not always possible. Ordinarily, congenital fusion is characterized by a slight waist-like contraction of the fused block. The disk spaces, as a rule, can be seen and appear to be smooth. The height of the block usually corresponds to the sum of two vertebrae because the block hypertrophies during the growth of the patient to make up for the missing or narrowed disks. If more than two vertebrae are fused, there are usually a shortening and some deformity of the spine. The fusion takes place chiefly in the upper part of the spine, mostly $C_2$–$C_3$. Acquired fusion usually shows calcific bone projections or lipping and bridging, the usual signs of a spondylosis.

In the area of congenital fusion there is always a definite narrowing of the intervertebral foramina, but never any clinical sign of pressure on the roots. There are occasionally accessory ossification centers in the spinous processes that may not ossify completely and lead to a separate apophysis, found mostly in the 6th and 7th cervical vertebrae. This must be differentiated from the fatigue fractures of the spinous processes caused by constant pulling of the trapezius and rhomboidei muscles, which also occur at the tip of the spinous process of the 6th and 7th cervical and 1st dorsal vertebrae. These fatigue fractures are found chiefly in persons who shovel earth with a hand shovel. The pull of the muscles usually distorts the fragment into a horizontal position, which can be distinctly recognized in the anteroposterior view.

One graph. WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

**Low-Back Pain. Prevention Through Medical Examination and Selective Job Placement.** Rex L. Diveley. Arch. Indust. Health **19:** 572–576, June 1959. (4312 J. C. Nichols Parkway, Kansas City 11, Mo.)

This paper is one in a symposium on low-back pain;

the other contributions are concerned with management and evaluation of disability.

Physical and roentgen examinations were made of 8,488 applicants for employment and the results are analyzed. Roentgenograms were taken of the chest and of the low back in two planes. If findings in the lumbosacral region were questionable, right and left oblique views were obtained. Eighty-seven per cent of the applicants were men and 13 per cent were women. The age range was from seventeen to fifty-three years, with an average of thirty-one years.

Congenital anomalies of the lumbosacral region were detected in 41 per cent of the spines examined; 40 per cent were considered normal. The roentgen findings in the lumbosacral region are listed in order of their importance: (1) congenital anomalies (spondylolisthesis; cleft or failure of fusion of the last lumbar vertebra; sacralized last lumbar vertebra), (2) arthritis, (3) postural defects, (4) wear-and-tear changes in the lumbar spine and/or lumbosacral joint.

While the x-ray findings cannot be used as the basis for employment, the author believes they can help in the proper placement of the applicant. In the present series, 3.8 per cent of all applicants were rejected and 12.7 per cent were given positions which they could fill without undue hazard. Such a program of pre-employment (or more accurately preplacement) examination of the low-back or lumbosacral area will save money for the employer or the insurance carrier and man-days lost by the employee. The employee, moreover, is placed in a position which he can fill without risk of injury to the lower back, and, being aware that he has a defect, he is careful not to aggravate it. These pre-employment records should prove most helpful in the evaluation of subsequent injury and disease and would be of material assistance in the adjudication of medicolegal problems.

Eight roentgenograms.

**Congenital Dysplasia of the Hip, with Special Reference to Congenital Subluxation or "Pre-luxation."** Rudolf Leffmann. J. Bone & Joint Surg. **41-B:** 689–701, November 1959. (15 Yarkon St., Mt. Carmel, Haifa, Israel)

Hip dysplasia is differentiated from frank dislocation and is believed frequently to be self-curable. In cases of limited abduction, even when the radiograph reveals a slanting or defective acetabular roof, or absence or irregularity of ossification of the femoral heads, or broken Shenton's line, the author is unprepared to institute active orthopedic measures, preferring to postpone therapy in the hope that spontaneous recovery may occur. He radiographs the patient at monthly or two-monthly intervals and relies on a trend of change rather than a single static film. There is no danger in waiting until eight months, the age of weight-bearing. If before that time a tendency to deterioration becomes obvious, that is, the eccentricity of the femur increases and the acetabular roof fails to grow out, treatment is started. When spontaneous recovery takes place the radiographs become normal, usually at the age of one and a half years, but sometimes later; the acetabulum comes to embrace the femoral head, and the small ossification center catches up with the larger one.

Eighty cases are reported. The interval before clinical and radiologic recovery was: three to five months in 17 cases; six to eight months in 44 cases; nine to twelve months in 12 cases; more than a year in seven cases.

Fifteen roentgenograms; 2 diagrams; 1 table.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

**An Adjustable Mobile Cassette Holder for Orthopaedic Operations.** E. Thyge Madsen. J. Bone & Joint Surg. **41-B:** 774–775, November 1959. (County and City Hospital, Vejle, Denmark)

A simple mobile cassette holder was constructed for use during orthopedic operations. It obviates the danger of personnel exposure because of its versatility in being mechanically maneuverable in various directions and angles. It consists of a telescoping upright arm set on casters for mobility. A horizontal arm is moved through a hollow T-fitting at the upper end of the upright. The cassette holder is attached to one end of the horizontal arm. Each of the joints is controlled by knobbed screws, which permit many adjustments in height, distance, angulation, and rotation. The apparatus has proved useful for many orthopedic purposes.

Four photographs. MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

## THE SPINAL CORD

**The Mobility of the Cervical Spinal Cord Under Normal Conditions.** Jan Jirout. Brit. J. Radiol. **32:** 744–751, November 1959. (Charles University, Prague, Czechoslovakia)

The author studied the anteroposterior movements of the cervical cord within the spinal canal under normal conditions in 120 individuals. Measurements were made from lateral pneumograms on patients who had no pathological involvement in the region of the cervical spine and its neighborhood.

It was found that at the level of the first cervical vertebra the average extent of anteroposterior movement of the spinal cord was 4.2 mm. At C-2 the average was 3.6 mm.; at C-3, 3.4 mm.; at C-4, 3.6 mm.; at C-5, 4.1 mm.; at C-6, 5.1 mm. From this it is apparent that the cord movements are least at the C-3 level, increasing above and especially below. However, the spinal canal narrows in its anteroposterior diameter from C-3 downward, so that the mobility of the cord does not depend solely on the width of the space available.

Anteflexion and retroflexion of the spine have some influence on position of the cord, but are probably less important than the movements of the spinal cord itself. The differences noted in positional changes of the body, *i.e.*, supine, prone, sitting, were found to reach as high as 9 mm.

While the cord movements were seen to be different at different levels, the mutual relation of the differences was relatively constant.

Pointing to earlier observations of his own (see, for example, Brit. J. Radiol. **32:** 188, 1959. Abst. in Radiology **74:** 319, 1960), the author observes that detection of diminution or absence of this normal mobility is diagnostically important and may indicate cord fixation by a tumor or arachnoid adhesions.

Sixteen roentgenograms; 7 schematic drawings; 4 graphs; 1 table. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

## GYNECOLOGY AND OBSTETRICS

**Hysterosalpingography in Genital Tuberculosis.** H. Kräubig. Fortschr. a. d. Geb. d. Röntgenstrahlen **91:** 654–663, November 1959. (In German) (Kreuzbergring 51, Göttingen, Germany)

Hysterosalpingography in tuberculosis of the female genital organs, which formerly was considered to be too dangerous, has become since the introduction of the water-soluble contrast media, a valuable diagnostic procedure. In the order of frequency, tuberculosis affects primarily the tubes (mostly bilaterally), then the uterine cavity, the cervix, and the ovaries.

While there is no definite pathognomonic roentgen sign of genital tuberculosis, there are several x-ray findings, particularly in the tubes, that make the diagnosis most probable. Confirmation must be obtained, however, by curettage, guinea-pig inoculation, or examination of the menstrual blood. The tubes often are straight, "wire-like," and lacking the usual delicate contortions. The ampulla is frequently widened, showing a "club-like" appearance. If, at the same time, it is patent, it may be considered as "typical" for tuberculosis. The contour of the filling is often ragged, "sawtooth-like," and fistulous tracts may be demonstrated. The filling of the ampulla itself may be patchy or incomplete. Filling defects within the tubes sometimes produce a picture suggesting a string of pearls or a rosary. Longitudinal hypertrophic mucosal folds are found more often in tuberculosis than in other lesions.

In the uterine cavity an irregular contour and incomplete filling are found also in other lesions but fistulous tracts point to tuberculosis.

Inasmuch as 5 to 10 per cent of all cases of primary or secondary sterility are due to a latent tuberculosis, hysterosalpingography may give important diagnostic suggestions. In the author's series of 78 proved cases of tuberculosis of the genital organs, patency at the uterine end of the tubes was present in 87 per cent, patency at the abdominal end in only 27 per cent.

Hysterosalpingography in tuberculosis is not free from danger. In 4 of his cases the author observed elevation of the temperature and in 1 case an exacerbation with abscess formation. He advises that the procedure be used only in the first half of the cycle, in the absence of fever, in the absence of acute inflammatory signs in the adnexa, and following prophylactic streptomycin administration. A cervical smear should always be obtained but a curettage should never be done shortly before or after hysterosalpingography.

Nine roentgenograms; 1 diagram; 1 table.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

**Caesarean Section Scar Safety.** L. O. S. Poidevin. Brit. M. J. **2:** 1058–1061, Nov. 21, 1959. (University of Adelaide, Adelaide, South Australia)

Hysterography is recommended by the author as a means of judging the safety of vaginal delivery in patients on whom cesarean section has been performed in the past. All post-cesarean patients have been found to show evidence of the scar at hysterography, varying from a shallow wedge to a larger irregular deformity. For such demonstration a lateral view must be used, since the scar will be on the anterior wall and may be hidden in any other position.

The author's observations indicate that vaginal delivery can be safely accomplished in patients with the commonly seen small wedge-shape deformities, but that cesarean section is indicated in subsequent pregnancies in the presence of irregular deformities of any size. In this latter group, the uterine incisions have apparently healed imperfectly, although nothing in the postoperative course consistently suggested the defective healing. Hysterography alone can delineate the type of scar.

Five roentgenograms; 2 photographs; 1 photomicrograph.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Sacro-coccygeal Teratoma of the Foetus with Special Emphasis on Prenatal Diagnosis by Radiology.** Vishnu Sarma and N. Nemiraja. Brit. J. Clin. Practice **13:** 628–633, September 1959. (Government Women and Children's Hospital, Egmore, Madras, S. India)

Sacrococcygeal teratomas arise in the tissues anterior to the sacrum and posterior to the rectum. Often they are benign but are said to have a "great propensity for malignancy."

The malformation of sacrococcygeal teratoma is so rare that seldom does the obstetrician entertain its possibility. The majority of cases are diagnosed when a vaginal examination is done to find out the cause for delay in birth. If the fetus presents by the breech, the characteristic feel of the tumor will be present and the bony landmarks of breech presentation will be recognizable above it. In vertex presentations there may be delay in the birth of the hind portion of the child, the rest of it having emerged.

The authors present films of what they believe to be the first roentgenographic demonstration of such a tumor, though actually the diagnosis was first suggested by vaginal examination following unexplained dystocia. On review of the films, the following criteria are suggested for presumptive roentgen diagnosis: (1) polyhydramnios, (2) straightening of the lumbosacral spine, (3) extension and anterior displacement of the lower extremities, (4) increased soft-tissue density extending from the base of the buttocks (the tumors usually are from 10 to 20 cm. in diameter), (5) calcification in the tumor mass, (6) high position of the fetus in breech presentation, as the tumor fills the maternal pelvis.

A surgical cure is usually possible.

Five roentgenograms; 3 photographs.

WENDELL M. BURNS, M.D.
Covina, Calif.

## THE GENITOURINARY SYSTEM

**Roentgenographic Analysis of Renal Mass Lesions (Cysts and Tumors).** Lawrence Reynolds, Harold Fulton, and James J. Snider. Am. J. Roentgenol. **82:** 840–846, November 1959. (L. R., Harper Hospital, Detroit 1, Mich.)

The authors analyzed 42 cases of renal cysts and tumors and found that in a high percentage differentiation between these two entities is possible. Their material consisted of 24 primary renal tumors and 18 simple renal cysts. Retrograde pyelography was done in all cases, and either a surgical or postmortem tissue diagnosis was obtained in each.

Special attention was given to the size of the kidney, size of the mass, size and shape of the pelvis and caly-

ces, and type and location of any calcification if present. The following conclusions are reached:

A primary tumor frequently enlarges the renal outline. A cyst usually does not. The outline of a tumor is indistinct; the shadow is contiguous with the kidney shadow and often of greater density. It may obliterate the psoas line. A mass caused by a cyst is in many cases attached to the periphery of the kidney, has a sharp outline and may be less dense than the kidney, producing a "double shadow," considered almost characteristic of a renal cyst.

The renal pelvis, depending on the location of either cyst or tumor, may be entirely uninvolved or it may be displaced or compressed. Deformity alone is no help in differentiation. If infiltration of the pelvic wall can be demonstrated, tumor is to be suspected.

Both tumors and cysts may cause distortion of the calyces unless the tumor is peripheral in location or the cyst is subcapsular. Tumors tend to produce calyceal elongation and sometimes amputation. There may be separation or compression of the calyces. Cysts result in elongation and compression or displacement, often causing a "crowding" together of the calyces. In general, calyceal deformity due to tumor has a more bizarre appearance than a deformity caused by a cyst.

Calcification is infrequent. It can be demonstrated in about 15 per cent of renal tumors and is usually centrally located and may be flocculent, linear, or fleck-like, spiculated or amorphous. A cyst shows calcification even less frequently; if present, it is linear or curvilinear, along the periphery of the mass.

While careful observation of above findings in many cases allows a correct differentiation between renal cyst and tumor, a definitive diagnosis is not always possible: in some cases (20 per cent of the present series of 42 patients) roentgenographic signs are not distinct enough; secondly, if findings allow a diagnosis of a cyst, the possibility of co-existing neoplasm within the cyst still has to be considered.

Ten roentgenograms; 2 diagrams; 3 tables.

MAX EICHWALD, M.D.
Encino, Calif.

**One Thousand Retrograde Pyelograms with Manometric Pressure Records.** James A. Ross. Brit. J. Urol. **31**: 133–140, June 1959. (Edinburgh Royal Infirmary, Edinburgh, Scotland)

One thousand retrograde pyelographic examinations were carried out with a mercury manometer in circuit to determine the point at which discomfort in the renal regions and pyelorenal backflow occurred. For 817 pyelograms (in 216 males and 205 females), the contrast medium was 12.5 per cent sodium iodide; for 67 (in 18 males and 16 females), a solution made up of equal parts of sodium iodide (12.5 per cent) and Pyelectan was used; in the last 116 (in 33 males and 31 females), an antispasomodic, Buscopan (hyoscine N-butylbromide), was added to the sodium iodide-Pyelectan mixture.

*Discomfort in the renal region* was recorded in 49 of the 996 examinations performed under local anesthesia of the urethra. It occurred with a pressure as low as 15 mm. Hg in 1 patient but was not experienced with a pressure of 100 mm. Hg in another. The average quantity of contrast medium injected into each renal pelvis in cases with discomfort was 5.4 ml. While there were 47 cases with discomfort in the first 880 readings (5.3 per cent), there were only 2 in the last 116 examinations (1.7 per cent) in which Buscopan was added to the contrast solution.

*Pyelorenal backflow* was observed in 27 of the 1,000 pyelograms. Pyelo-interstitial backflow was the commonest form, being seen in 20 cases; pyelotubular backflow occurred in 2 cases, pyelolymphatic in 1, pyelotubular-pyelolymphatic in 1, pyelovenous in 2, pyelovenous-pyelolymphatic in 1. In 24 of the 27 cases with pyelorenal backflow, the kidneys were normal. The average pressure recorded in the cases with backflow was 50.2 mm. Hg, a figure actually lower than that for the whole series, 53.6. In 10 cases of pyelorenal backflow, there was some discomfort.

The author concludes that neither the pressure reading nor discomfort is a reliable guide as to the state of filling of the renal pelvis during retrograde pyelography, or an indication that reflux has occurred.

Two pyelograms; 1 photograph.

**Fluoroscopy During the Removal of Renal Calculi.** N. J. Nicholson. Brit. J. Urol. **31**: 249–253, September 1959. (Louth, Lincs., England)

The author believes that the taking of films during the removal of renal calculi is a slow and unwieldy process and that fluoroscopy offers a welcome alternative. He thinks the need for dark adaptation has perhaps been overstressed. Experiments conducted on different calculi embedded in a cadaveric kidney showed that in a room subtotally dark, with settings of 50 kvp and 4 ma, calcium phosphate stones could be seen at once on the fluorescent screen without any dark adaptation. Stones composed of cystine and of calcium oxalate could also be seen without delay, though less distinctly than those of phosphate. Urate stones were not well visualized even after waiting in a darkened room for twenty minutes.

The apparatus employed during the fluoroscopic procedure is illustrated. The kidney is grasped in a special forceps which consists of two detachable stainless-steel angulated sections held together by a single box joint. Each section has a fenestrated blade and is curved at the other extremity to form a handle. The blades are slightly concave to follow the contours of the kidney. In the blade farthest from the applicator, provision is made to retain a removable fluorescent screen. The oval aperture in the other blade is open and the kidney substance prolapses slightly through it when the kidney is held. As an additional aid to support the kidney in the forceps, two curved blunt prongs are attached to the underside of the open aperture. As the individual case may require, alternative forceps, without the prong supports, may be used. To effect adequate compression of the kidney against the fluorescent screen, a rachet device, easily actuated by gentle finger pressure, is incorporated in the forceps handles. The fluorescent screen is oval in shape and has an effective viewing area of approximately 2 3/4 × 1 3/4 in. Indirect viewing of the kidney on the screen is achieved by a large version of the ordinary dental mirror.

Measures taken for protection against radiation and for sterilization of equipment are discussed.

Four photographs.

**Further Experiences with the Radioisotope Renogram.** Chester C. Winter. Am. J. Roentgenol. **82**: 862–866, November 1959. (University of California Medical Center, Los Angeles 24, Calif.)

The radioisotope renogram is obtained by intrave-

tions administration of a urographic contrast medium which has been labeled with $I^{131}$ and continuous recording of the gamma-ray activity emanating from each kidney. Details of the technic and of interpretation of the curves thus recorded are fully outlined. The procedure was originally described in 1956 (Winter: J. Urol. **76:** 182, 1956. Abst. in Radiology **68:** 903. 1957) and has not been materially changed.

The renogram does not afford information that cannot be obtained by other methods, but it often reveals more than any one of the conventional renal tests, and more easily. The results are qualitative, and give information about the renal vascular capacity, tubular cell function, and drainage of urine from the kidney. Direct comparison of right and left renograms has been particularly useful.

The author has performed over a thousand renographic studies among individuals with normal and abnormal kidneys, and in animals, giving special attention to the study of the kidneys in hypertension. Over 30 per cent of hypertensive patients were found to have normal kidneys bilaterally. This would seem to justify routine radioisotope renography in this group, since thereby extensive and expensive urologic investigation may frequently be avoided.

Interesting observations were also made during neurogenic and surgical shock. In neurogenic shock urine formation continues normally, but due to spastic constriction of the ureter there is stasis of urine in the renal pelvis for fifteen to twenty minutes. During surgical shock the tubular cells retain their ability to secrete the medium, although water is not excreted.

No untoward reactions occurred in this series, and the radiation hazard is not significant.

One photograph; 4 renographic tracings.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Phlebography of the Renal Vein by Way of the Left Spermatic Vein.** Gospodin Iv. Gospodinow and Jovtscho B. Topalow. Fortschr. a. d. Geb. d. Röntgenstrahlen **91:** 664–669, November 1959. (In German) ("Belo More"-Str. 8, Sofia, Bulgaria)

The authors have investigated the feasibility of doing phlebography of the left renal vein by way of the left spermatic vein. The procedure was first carried out on 11 cadavers. Good visualization of the veins of the left kidney was obtained. Dogs were next used. No immediate ill effects were produced, and histologic examination of the testes of the animals showed no pathologic changes. Finally the examination was done on 3 patients with a left varicocele. An incision, 3 cm. long, was made in the upper portion of the scrotum along the anterior surface. One of the veins of the pampiniform plexus was isolated and opened. The distal end was ligated, and a cannula was tied into the proximal end. With a syringe holding 40 c.c. of 50 per cent Joduron, 10 c.c. was slowly injected into the cannula (about 5 seconds), so as to fill the long run of the spermatic vein. The remaining 30 c.c. was then injected as rapidly as possible. A film was taken upon completion of the injection and another 10 seconds later.

The authors obtained satisfactory visualization of the spermatic vein and of the renal vein with its ramifications. They believe the method may be of great value to test the patency of a splenorenal anastomosis postoperatively and may give important information about tumors of the left kidney (hypernephroma) as well as the existence of metastases in the lumbar region following tumors of the testis.

Seven roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

**The Technique and Interpretation of Nephrotomograms.** H. W. A. Post and W. F. W. Southwood. Brit. J. Radiol. **32:** 734–738, November 1959. (West London Hospital, London, W. 6, England)

Space-occupying lesions of the kidney can advantageously be studied by nephrotomography. The chief value of the procedure appears to lie in the differentiation between renal tumors and cysts.

The test appears relatively simple and safe. Kidney levels for tomograms are preselected, and 20 c.c. of 45 per cent Hypaque is given intravenously (to reinforce the subsequent nephrogram). Body section radiographs are then made immediately following rapid intravenous injection of 50 c.c. of 90 per cent Hypaque.

The first film should demonstrates the renal arteries and their branches. The second, two or three seconds later, is a nephrogram showing the renal parenchyma. Two or more additional tomographic films are then rapidly obtained. Ideally the whole series of films should be completed in less than forty-five seconds.

Radiographically, renal tumors in the arteriographic phase have a dense vascular pattern, while cysts are characteristically almost avascular. On the nephrogram, tumors have a poorly defined margin and rather dense opacification, whereas cysts appear as radiolucent areas, sometimes with a surrounding halo of increased density. Tumors may undergo central necrosis and show irregular, blotchy opacity, but the x-ray appearance is clearly different from the well defined translucency of a cyst.

The authors caution that the technic is apt to be unreliable in excluding neoplasms of the renal pelvis.

Two brief illustrative case reports are presented.

Eight roentgenograms; 2 photographs; 7 diagrams.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Pelvic Angiography in Diseases of the Prostatic Gland.** A. Bobbio, E. Bezzi, and L. Rossi. Am. J. Roentgenol. **82:** 784–792, November 1959. (A. B., University of Parma, Parma, Italy)

Selective arteriography for visualization of pelvic vessels primarily for the study of the prostate gland is described.

Each side must be examined separately in order to show the prostatic vessels to best advantage. Although patients need not necessarily be anesthetized, the authors do all their studies under general anesthesia, since they believe that local vasomotor reactions are thus minimized.

An excellent topographical and vascular anatomic study is presented. Changes secondary to infection, hypertrophy, and tumor are illustrated. Some of these are difficult to interpret. The authors state that findings are not as outstanding as the findings in angiography of other organs, but when the procedure is correctly performed, it may give useful information in the differential diagnosis of prostatic diseases. In the presence of prostatic adenoma there was observed a widening of the angle between the lower vesical and middle hemorrhoidal arteries which encircle the lateral border of the prostate. The capillary and venous

phases, as in the normal prostate, are not visualized. Chronic prostatitis causes no particular changes in the morphology or functional aspects of the prostatic circulation except for some decrease of the blood supply when severe sclerosis of the gland has taken place. In the presence of a malignant growth, the angiographic pattern resembles that observed in malignant tumors of other organs, consisting in a rich irregular blood supply, pooling of blood, staining of the parenchyma, and early venous drainage.

Seventeen roentgenograms.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

## MISCELLANEOUS

**Diagnosis of Left-Sided Subphrenic Abscess.** Martin C. Rosner and Morton A. Bosniak. J. A. M. A. **171:** 1282–1286, Nov. 7, 1959. (M. A. B., New York Hospital–Cornell Medical Center, New York, N. Y.)

The authors present a typical case of left-sided subphrenic abscess demonstrated following ingestion of a carbonated beverage. The air bubble in the fundus was displaced downward and an impression was seen on its superior lateral aspect.

The clinical and radiologic diagnostic criteria of subphrenic abscess are reviewed. Such abscesses on the right side are limited inferiorly by the liver and are, therefore, more apt to affect the diaphragm. On the left side the adjacent organs—spleen, stomach, colon, and left lobe of the liver—are easily displaced by the abscess.

The authors believe that air is superior to barium as a contrast medium in the stomach in the study of left-sided subphrenic abscess, because it is much lighter than barium and therefore the stomach wall can be indented more easily, allowing a small abscess to be seen more readily. Also, air will expand the fundus of the stomach to a greater extent than barium and has a greater chance of coming in contact with a subphrenic collection. In case of a perforation it is much safer to administer air and fluid than barium.

Three roentgenograms. WILLIAM MARTEL, M.D.
University Hospital, Ann Arbor, Mich.

**Calcified Adrenal Cysts.** A. J. Palubinskas, W. R. Christensen, J. H. Harrison, and M. C. Sosman. Am. J. Roentgenol. **82:** 853–861, November 1959. (A. J. P., University of California Medical Center, San Francisco 22, Calif.)

Adrenal cysts are rare, about 80 cases having been reported. To these the authors add 4.

Complaints are noncharacteristic, including flank or back pain. None of the patients had any demonstrable hormonal abnormalities. The scout film of the abdomen is the most helpful diagnostic tool, revealing a mass in the adrenal area. Often displacement of the kidney, with accompanying distortion of the upper calyx, is present. Cysts or tumors of the spleen, pancreas, liver, kidneys, and mesentery, as well as empyema of the gallbladder, splenic artery aneurysms, dermoid, hydatid, chylous or urachal cysts, and solid adrenal tumors have to be considered in the differential diagnosis.

In all 4 of the authors' cases roentgenographic evidence of peripheral curvilinear calcifications in the cyst wall was present. It is concluded that any mass in the suprarenal area showing this type of calcification should be suspected to be a benign adrenal cyst.

Five roentgenograms; 3 photographs.

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# RADIOTHERAPY

**Malignancies of the Paranasal Sinuses.** William G. Hemenway and John R. Lindsay. Arch. Otolaryng. **70:** 61–64, July 1959. (950 E. 59th St., Chicago 37, Ill.)

During a period of approximately twenty-five years only 62 cases of malignant tumor originating within the paranasal sinuses were encountered in the University of Chicago Clinics. All of the tumors arose in the antra or ethmoids. There were no primary growths of the sphenoidal or frontal sinuses but these were occasionally involved secondarily. Thirty-four patients were men and 28 were women.

In all cases roentgenography showed clouding of one or more sinuses; in 66 per cent there was definite destruction of the bony sinus walls when roentgen examination was first made. This finding is practically diagnostic of a malignant tumor. Fifty-six of the tumors were carcinomas, the majority being of the squamous-cell variety. Six tumors fell into the sarcoma group (1 neurogenic sarcoma, 1 sarcoma of undetermined nature, 3 plasmacytomas, 1 reticulum-cell sarcoma).

In only 51 of the 62 cases was sufficient information available as to treatment and follow-up for them to be considered definitive. Results in the sarcoma group were the most promising. Of the 6 patients with sarcoma, 5 are alive and well. In the remaining case initial surgery was too conservative because of an original pathological diagnosis of a benign lesion. The other 5 cases were treated by x-ray therapy alone. The 3 patients with plasmacytoma are alive and well after three and a half, four, and six years. One patient with sarcoma of undetermined type (probably reticulum-cell sarcoma) is alive and well after thirteen years, and 1 patient with reticulum-cell sarcoma is alive and well after eight years. In the carcinoma group, only 4 of 27 patients with squamous-cell tumors are alive and well, while 3 of 12 with adenocarcinoma are free of disease. None of the 6 patients with unclassified carcinoma has survived.

Treatment of the carcinomas in this series was by irradiation, surgery, or a combination of the two. Prior to 1948 radiotherapy predominated. Since that time, treatment has consisted primarily of radical surgical exenteration. Nineteen cases have been treated since 1947. Eight patients received x-ray therapy primarily; in 5 cases this was followed by radical surgery for recurrence. Six patients are dead and 2 are alive with persistent tumor. All 8 cases are regarded as failures. In 11 cases surgery was the primary method of treatment; in 7, radical resection of the tumor was followed by irradiation. Six of the 11 patients are alive and well after periods ranging from four to eleven years. Disability after surgery is minimized by suitable prosthetic appliances. All postoperative patients who are free of disease are leading reasonably normal lives.

**Hyperkeratosis of the Larynx.** Arthur J. Cracovaner. Arch. Otolaryng. **70:** 287–291, September 1959. (103 E. 78th St., New York 21, N.Y.)

Hyperkeratosis of the larynx is a precancerous lesion and must be treated as potentially malignant. Each case must be judged according to the extent of the lesion, the size, the appearance, the site, and the microscopic findings. It is difficult to assign definite rules for treatment, but the author presents certain examples and indicates what he regards as the best procedure.

The early hyperkeratotic lesion may appear as a small, red thickening on the edge of the vocal cord. It may be located in the anterior or middle third of the cord, or in both areas. Sources of infection and irritation from overindulgence in alcohol, excessive smoking, abuse of the voice, and inhalation of dust and fumes should be eliminated. Some of the lesions may subside on this regimen; usually, however, it is necessary to strip the involved area from the vocal cord under direct laryngoscopy. If the keratosis has a tendency to recur after repeated removal, then more radical measures must be undertaken. The author prefers to remove the involved cord by laryngofissure. Lesions that recur on both vocal cords are treated by irradiation (a full tumor dose). If this is unsuccessful, laryngectomy is carried out. Extensive involvement of the larynx by a warty papillomatous-appearing lesion is treated by laryngectomy. Any growth which on microscopic examination shows the presence or suspicion of malignant change is regarded as a carcinoma, and laryngofissure is performed.

Three figures.

**The Estimation of the Proportion of Patients Cured After Treatment for Cancer of the Breast.** J. L. Haybittle. Brit. J. Radiol. **32:** 725–733, November 1959. (Addenbrooke's Hospital, Cambridge, England)

Since cancer of the breast is a disease with a long natural history and frequent late recurrences, the five-year survival rate is a rather unsatisfactory index of success in treatment. The author here attempts to correlate survival statistics with mathematical functions to show what fraction of patients is actually cured; and to estimate what that fraction may be when the follow-up period is comparatively short.

It is suggested that the probability of dying from cancer of the breast decreases exponentially with increasing time after treatment. A statistical review of 385 breast cancer patients from Royal Cancer Hospital and of 528 cases from Christie Hospital and Holt Radium Institute, all with long-term follow-up, seems to fit well with that assumption.

Full details of the method of application are given, using the "extrapolated actuarial" model for solution; and comparisons are made with lognormal and exponential models, which present difficulties that are discussed by the author.

Four graphs; 9 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**The Use of Chemotherapeutic Agents and Roentgen Ray Therapy in Carcinoma of the Lung.** Jesshill Love and Wesley G. Farnsley. J. Kentucky M. A. **57:** 1372–1381, November 1959. (W. G. F., St. Joseph Infirmary, Louisville, Ky.)

The authors' experience indicates that bronchogenic tumors "respond more completely and promptly when x-ray therapy is given immediately after adequate nitrogen mustard therapy." In their department, nitrogen mustard is now given almost routinely after operative procedures for carcinoma of the lung. Dosages utilized are the same as described by others, namely 0.1 mg. per kilogram of body weight daily for four doses or, at times, a single maximum dose of 0.4 mg. per kilogram of body weight. Occasionally the pleural cavity has been washed thoroughly at the time of operation with a weak solution of $HN_2$ (10 mg. per 500 c.c. of water).

In a related personal study, 13 of 28 patients on whom biopsies had been performed prior to lobectomy or pneumonectomy were found to have cancer cells in pleural washings. In striking contrast, pleural washings from only 3 of 21 cases were found to contain malignant cells where the resection was *not* preceded by biopsy. On this basis the authors raise the question of advisability of biopsy prior to resection.

Experiences in the treatment of 47 patients with lung cancer by 2-Mev x-rays are briefly reported. Thirty-four of these patients had been followed for one or more years since therapy. Eight had survived for eighteen months, with an average survival of ten months. The advantage of 2-Mev diagnostic x-ray films in demonstrating the degree and site of tumor involvement as compared with conventional films is noted. The authors' methods of management with 2-Mev x-ray therapy are outlined. Irregularly shaped beams are used to cover the tumor and its metastases. Anterior and posterior fields usually suffice to introduce depth doses in the 5,500 r range in five weeks. The great advantage of supervoltage therapy is stressed. The authors feel it would be instructive and informative to treat a series of "operable" lung cancers with controlled and carefully directed supervoltage x-rays without use of surgery.

Seven roentgenograms; 1 photograph; 3 diagrams; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Treatment of Pulmonary Metastases with X-Ray Therapy.** Charles L. Martin. Texas State J. Med. **55:** 866–872, November 1959. (3501 Gaston Ave., Dallas, Texas)

The author reports a series of 14 cases of metastatic carcinoma of the lung managed by relatively small doses of radiotherapy to the chest. Most of the patients had either metastatic adenocarcinoma or squamous-cell carcinoma, and a wide variety of primary neoplasms are represented. Radiotherapy was administered with conventional equipment (200 to 250 kv) through two opposing portals, 15 × 15 cm., over the zone of metastasis, so that about one-half of one lung was irradiated. If other areas were involved, additional fields were used in a similar manner. Doses of approximately 1,300 r were delivered to the mid plane of the chest in nine or ten days. Of the 14 patients, 13 showed definite improvement in the roentgenographic appearance of the pulmonary lesions; 5 showed complete regression; and marked improvement was observed in 2 others. As was to be expected reappearance of the lesions generally occurred six to thirty months later.

Because of his favorable results, the author in some instances repeated the treatment as described above when the recurrent lesions appeared. Further therapy was almost always followed in a few months by serious fibrosis or radiation pneumonitis.

A table is presented which summarizes important

data on the 14 patients in this series. Four of the cases are described in moderate detail.

It is concluded that pulmonary metastases from various types of cancer can often be markedly improved by the administration of small doses of roentgen rays as described. A technic which delivers a mid-plane dose in the range of 1,300 r in about ten days will seldom produce serious pneumonitis even when both lungs are treated.

Twelve roentgenograms; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Effects of Preoperative Irradiation on Adenocarcinoma of the Uterus.** Herbert E. Schmitz, Charles J. Smith, and William C. Fetherston. Am. J. Obst. & Gynec. **78:** 1048–1054, November 1959. (C. J. S., 55 E. Washington St., Chicago 2, Ill.)

Two series of cases of adenocarcinoma of the uterus are presented: 138 cases from 1934 to 1945 and 142 cases from 1946 to 1953. The earlier series has been previously reported (Am. J. Obst. & Gynec. **64:** 952, 1952. Abst. in Radiology **61:** 462, 1953). The results in the second group reflect improved irradiation and surgical technics. The 280 cases include all admissions to the Gynecologic Service of the Mercy Hospital Institute of Radiation Therapy (Chicago) for the years covered, for endometrial carcinoma, regardless of the extent of disease or previous therapy.

The 71 patients of the later group received treatment according to the authors' preferred technic. This consisted in insertion of the Y radium applicator for 2,000 mg. hours weekly for three weeks for a total dose of intracavitary radiation of 6,000 mg. hours. On the intervening days and continuing after the third radium application, deep x-ray therapy was delivered to the mid pelvis with a 1,000-kv machine, through anterior and posterior ports, for a total dose of 3,500 to 4,000 r. In six to eight weeks a total hysterectomy with a generous cuff of vagina and a bilateral salpingo-oophorectomy were performed.

Preoperative irradiation by this technic in the operable group destroyed endometrial carcinoma in 75 per cent of cases and produced an 81.6 per cent five-year survival rate. In the group of 55 patients treated and found to have no residual tumor in the surgical specimen, the corrected five-year survival was 96.6 per cent.

For the total series of 71 cases there was a 20 per cent improvement in five-year end-results as compared to the earlier group—67 per cent survivals as compared to 47.4 per cent. There was also a 20 per cent increase in sterilization of the tumor prior to surgery.

The authors suggest that, in addition to the less likely survival of disseminated cells previously irradiated, fractionated irradiation produces an individual tumor-host resistance by a general somatic response to profound physiological injury or an increase in resistance mechanisms through stimulation of radiant energy.

Three figures.

ROBERT L. EGAN, M.D.
University of Texas, Houston

**Cellular Changes in Vaginal and Buccal Smears After Radiation: An Index of the Radiocurability of Carcinoma of the Cervix?** Howard W. Jones, Jr., Benjamin Goldberg, Hugh J. Davis, and Beaury C. Burns, Jr. Am. J. Obst. & Gynec. **78:** 1083–1098, November 1959. (The Johns Hopkins Hospital, Baltimore, Md.)

The difference in the response to radiation of apparently similar cervical cancers is ascribed to the somewhat intangible quality *radiosensitivity*. Ruth and John Graham (Cancer **8:** 59, 1955. Abst. in Radiology **66:** 153, 1956) have developed a concept and technic for predicting radiocurability by examination of exfoliated vaginal cells. They observed certain morphologic changes in the normal vaginal cells following irradiation; these changes were called radiation response (RR) and a correlation between a critical percentage of cells showing radiation response and radiocurability was detected. In 1955, the present authors began an investigation directed toward repeating the findings of the Grahams, but unfortunately these studies were unsuccessful.

In order to overcome the problem of cell identification, to aid in minimizing the endocrine influence, and to assure a standard radiation dosage, the test site was then moved away from the tumor and a standardized dosage (1,500 r) of roentgen rays was administered to a uniform area of the buccal mucosa. Following this, the changes in cells gently scraped from the test area were studied. The cell count was made by the same criteria employed in the Graham vaginal cell technic except that the critical level of response was considered to be above 65 per cent rather than above 75 per cent. Two features of radiation cytotoxicity—macrocytosis and multinucleation—proved to lend themselves well to objective measurement and correlated in high degree with the clinical end results in the retrospective study of 50 Stage I and Stage II carcinomas of the cervix. With multinucleation as the sole criterion, the prognostic error was but 12 per cent in these operable patients.

Twenty figures; 2 tables.

**Carcinoma of the Bladder.** Noel Thompson. Brit. J. Urol. **31:** 287–297, September 1959. (Royal Victoria Infirmary, Newcastle upon Tyne, England)

Of 146 consecutive patients treated for tumor of the bladder over a ten-year period (1947–1956) at the Royal Victoria Infirmary, 75 had non-infiltrating papillary growths and 71 had infiltrating growths. The present analysis is concerned with the 71 cases of infiltrating bladder growths, including both papillary and non-papillary types. Fifty-four of the patients were men and 17 were women; 63 were between fifty and eighty years of age. All patients were traced. Of the survivors, all but 3 had had recent cystoscopic examinations.

Histologic reports were available on 40 of the tumors: transitional-cell carcinoma, 25; villous carcinoma, 3; squamous-cell carcinoma, 4; anaplastic carcinoma, 4; adenocarcinoma, 2; leiomyosarcoma, 1; angio-endothelioma, 1. All of the growths were primary in the bladder except the angio-endothelioma. Fifty of the 71 infiltrating growths were situated at the base of the bladder and 12 on the lateral wall; the remainder were scattered more or less uniformly elsewhere. Of the 50 basal growths, 15 were in immediate relationship to a ureteric orifice, 16 were on the trigone, and 18 had spread to involve lateral walls or fundus in addition to the bladder base. In 1 patient the growth occurred in a sacculus on the base of the bladder.

The presenting symptom in 2 patients is not recorded; 55 patients complained of hematuria; 6, frequency; 3, dysuria; 2, vesical calculus; 1, strangury; 1, pain; 1, retention.

The gross pathological appearance, as seen through the cystoscope, proved to be of prognostic significance. Patients with pedunculated growths showed almost

double the survival rate of those with sessile growths (41.7 and 23.7 per cent).

Of the 70 cases of primary bladder tumor, 14 were treated by surgery alone, 21 by radiotherapy alone, 21 by a combination of surgery with radiotherapy; 14 were considered too advanced for any treatment except the administration of analgesics.

Three of the 14 patients treated by *surgery* were alive at the time of the report, with an average survival period of 5.8 years. Only 2 of the 11 patients treated more than five years ago still survived, giving a five-year survival figure of 18.2 per cent.

All 21 of the patients treated by *radiotherapy* were considered surgically inoperable on the basis of the cystoscopic examination, bimanual palpation, and in 7 cases endoscopic biopsy. Five patients were still alive after periods of one to three and a quarter years. There were no five-year survivals, but the three-year survival rate is 1 case out of 11. Of the 21 patients, 9 survived one year. *Radium* was employed locally in 4 cases, in 3 combined with conventional x-ray therapy or radioactive cobalt. It afforded the most impressive palliation in this group. It was used usually in massive but localized, sessile, fixed growths of the bladder base. *Conventional deep x-ray therapy* was administered in 13 patients; 2 of these were alive after two years and 5 survived one year. *Megavolt deep x-ray therapy* was given to only 3 patients; one survived for a year, and in this case the cystoscopic appearance became normal. Radioactive cobalt was used in the single case of leiomyosarcoma, involving almost the whole bladder, as a means of halting severe and continuous hematuria; this it succeeded in doing, but the patient died three months later.

Of the 21 cases treated by *combined surgery and radiotherapy*, 9 were alive after periods of eight months to four years (average two years), but 3 of the tumors showed evidence of recurrence at the time of this report. Only 2 of 8 patients had survived five years, 7 of 13 for three years, and 18 of 21 for one year. The combinations of therapy employed were: open diathermic excision plus deep x-ray therapy; palliative transplantation of ureters into the colon plus deep x-ray therapy; open diathermic excision plus radium; open diathermic excision plus radon implantation; open diathermic excision plus radioactive cobalt; partial cystectomy plus radiotherapy.

Patients selected for treatment by surgery alone were those in whom the bladder lesion was considered to be completely removable. Despite this fact, the survival rates in patients treated by a combination of surgery and radiotherapy, in many of whom the growth was believed to be advanced, were at all stages better. Thus combined therapy demonstrated its superiority over surgery alone—in five-year survivals by 25 per cent compared to 18 per cent, and in three-year survivals by 54 per cent compared to 33 per cent.

Four figures; 3 tables.

**Interstitial Radiation in the Treatment of Selected Cases of Cancer of the Bladder.** J. H. Carver. Brit. J. Urol. **31:** 313–316, September 1959. (St. Mary Abbot's Hospital, London, England)

Ninety-nine selected cases of cancer of the bladder were treated by local excision and interstitial radiation between 1949 and 1956 at the Joint Consultative Clinic of St. Mary Abbot's Hospital and the Radiotherapy Department, Lambeth Hospital, London. The grounds for selection were that the tumor should be T1 or T2 in the Dukes classification and the tumor base should not exceed 5 cm. in diameter. The diagnosis and assessment of these tumors represented a combined effort of the radiotherapist and the surgeon. At operation, after removal of the tumor, interstitial radiation was applied by the radiotherapist and he was present at all the subsequent follow-up cystoscopies. Radon seeds were used between 1949 and 1952; after that gold grains were employed. They are cheaper and can be reactivated if operation has to be postponed. The seeds are introduced by a repeater gun which is quicker than the old method of trocar and cannula. The dose varied from 4,000 to 7,000 r.

In 7 patients a radium ulcer developed which persisted from six to twelve months. One patient had a very severe radium cystitis with half-hourly frequency, and ureteric transplantation had to be performed. There were 4 operative deaths.

Sixty-five patients were free of growth for two to nine years after operation. Eight patients who died of other causes were cystoscopically free of tumor before death; 3 of these patients died the same year and the other 5 lived from one to seven years after operation. There were 17 deaths from cancer of the bladder. Of the patients who were alive and tumor-free at the time of the report, 36 had tumors classified as T1 and 29 tumors classified as T2. Seventeen patients died of bladder cancer (3 T1, 14 T2).

On the basis of the results in this series, the author considers local excision and interstitial radiation a satisfactory method of treatment for T1 and T2 bladder carcinoma.

Four tables.

**Therapy and Prognosis of Melanoblastoma.** Paul Hess. Strahlentherapie **110:** 413–419, November 1959. (In German) (Krankenhaus Bethesda, Duisburg, Germany)

Although modes of treatment of melanoblastoma have been discussed in the literature for a long time, there still exists a lack of uniformity. Generally, the surgical approach is considered the method of choice. Nevertheless, five-year cure rates as low as 14 to 38 per cent are still reported, and postoperative radiation has failed to produce an improvement. Because of the poor end results, increasingly radical procedures are advocated, including roentgen therapy up to 30,000 r.

The author leans toward a conservative approach, with elimination of surgery altogether. He confines himself to contact therapy with fractional doses of no more than 500 r up to a total of 8,000 r.

Biopsy proof is no longer considered essential, as malignant change is suggested by the clinical evidence, namely, a long-standing nevus pigmentosus papulosus or verrucosus, which develops a blueish-black discoloration, slowly increases in size, and shows marginal infiltration of the underlying tissues.

Among 47 cases treated during the past ten years there were 29 nontraumatized, treated solely by roentgen rays. Twenty patients survived, while 7 died from the disease and 2 from an intercurrent illness. Of 9 patients in whom biopsy was done prior to roentgen treatment, only 4 survived. Eighteen patients were referred for roentgen therapy postoperatively. Of these, 14 died, 2 had metastatic spread, and only 2 remained asymptomatic. When all surgically traumatized cases are pooled together, there remains a survival

rate of 30 per cent. This compares with 80 per cent for cases given only contact therapy without preceding biopsy.

Five tables.

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**Hemangiopericytoma. A Report of Four Cases with a Review of the Literature.** Zuheir Mujahed, Anthony Vasilas, and John A. Evans. Am. J. Roentgenol. **82:** 658–666, October 1959. (525 E. 68th St., New York 21, N. Y.)

To 57 cases of hemangiopericytoma appearing in the literature the authors add 4. Study of all cases shows no relationship between the occurrence of this tumor and the age or sex of the patient. There is no proclivity for any specific location in the body. The chief cellular component is the pericyte, a modified smooth muscle cell, closely applied to the capillary wall, which regulates the size of the capillary lumen. This is the same cell that gives rise to the epithelioid cell of the glomus tumor. Hemangiopericytoma differs from glomus tumor, however, in that it lacks the cellular organization of the latter and it has a neuromyoarterial component. Other distinguishing features are the absence of pain in the tumor, the capacity for aggressive infiltration locally, and the production of distant metastases. It differs from capillary hemangioma on the basis of cellular derivation. Two prerequisites are necessary for the diagnosis of hemangiopericytoma: (1) endothelial cells must retain their normal appearance and be separated from the pericytes by a fibrous sheath; (2) the proliferating cell must be the pericyte.

Clinically the lesion is a firm, circumscribed nodule 1 cm. to 20 cm. in diameter which grossly appears encapsulated but is seldom found to have a capsule on microscopic examination. When pain occurs, it is due to compression of neighboring nerves. The rate of growth is variable. Radiographic examinations show a well demarcated soft-tissue mass which may or may not contain calcium. It cannot be differentiated radiographically from other soft-tissue tumors. When it is located in close proximity to a bone, there may be erosion of the underlying bone by the pressure of the tumor.

In the majority of cases surgical excision has been the method of treatment. The incidence of local recurrence and distant metastasis is quite high. Cases receiving x-ray therapy either to the primary lesion or to recurrences and metastases seem to show beneficial effects in the form of decrease in size of the mass, reduction of pain, or arrest of growth. Tumor doses ranged from 3,400 to 7,100 r. The most important use of radiation appears to be in early cases when a complete excision of the tumor is attempted. This group shows a high incidence of local recurrence, and adequate radiation therapy may well eliminate a large number of recurrences and reduce metastasis.

[Since the publication of this paper there has appeared in RADIOLOGY a report of 5 cases of hemangiopericytoma with a discussion of its radiation treatment (Friedman, M., and Egan, J. W.: Radiology **74:** 721, 1960).—Ed.]

Seven roentgenograms; 1 photomicrograph; 1 table.

RICHARD F. MCCLURE, M.D.
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**Roentgen Therapy of Certain Complications of Acute Leukemia in Childhood.** Giulio J. D'Angio, Audrey E. Evans, and Anna Mitus. Am. J. Roentgenol. **82:** 541–553, September 1959. (Children's Medical Center, Boston 15, Mass.)

The authors studied 372 children with acute leukemia between 1953 and 1957. All of the group received chemotherapy, and 95 were given radiotherapy to control the secondary manifestations of the disease. The authors believe that when disabling and persistent symptoms appear, a trial of radiation in small doses is worthwhile. They found that symptoms referable to involvement of the central nervous system, bones and joints, urinary tract, and skin and mucous membrane were most amenable to radiation therapy.

Thirty-seven of the 372 children exhibited symptoms referable to the central nervous system, including headache, nausea, vomiting, papilledema, tremors, and cranial nerve palsies. Lumbar puncture improved the conditions of approximately half of these patients. Antifolic compounds administered intrathecally after lumbar puncture in 4 of these children apparently failed to enhance the effects. Irradiation of the skull, on the other hand, with or without prior lumbar tap, produced more lasting beneficial effects in 70 to 75 per cent of these children.

On the basis of their experience, the authors believe that the method of choice for control of the central nervous system symptoms developing as a consequence of extensive leukemia consists in lumbar puncture followed by roentgen therapy to the skull if symptoms persist or recur within a few days. They rarely exceeded a total depth dose of 450 r. If a satisfactory response was obtained at a lower dose, treatments were discontinued. In patients whose response was poor after the administration of 450 r, therapy beyond this level failed almost uniformly to provide amelioration. Alopecia occurred in many of the patients treated and was believed to represent the combined effects of the chemotherapeutic agents employed and the irradiation, since epilation would not ordinarily be expected so consistently with the small roentgen doses delivered to the skin. Regrowth of hair occurred within a few months.

Twenty-five children received radiotherapy for bone and joint pains. Eighty-five per cent of the episodes treated were controlled after relatively small doses of radiation. Initial single air doses of 200 to 300 r not infrequently produced relief. Pushing the depth dose beyond the 450 r level provided no appreciable improvement in results.

Cutaneous and mucous membrane infiltrations can produce pustular and nodular mass lesions as well as foul ulcers in the patient with acute leukemia. Nineteen patients with 26 local lesions were treated for this complication. In approximately one-half the children, a satisfactory response was obtained. Two hundred to 300 r (air) was given daily every other day. It was rarely found necessary to go above the 450 r depth dose.

Hematuria is of common occurrence in acute leukemia in childhood. Only 18 of the 372 children studied, however, received radiotherapy for this complication. Many in whom hematuria developed were either terminal or were managed by other means. In 35 per cent of those treated by irradiation, satisfactory results were obtained. Although pathologically it has been found that the kidney usually shows the most striking changes, empirically, roentgen therapy of the urinary bladder has been found to yield the most satisfactory results. In 3 children, the kidneys were irradiated after

bladder irradiation had yielded no benefit. Two of these patients failed to improve.

Eleven patients received roentgen therapy because of symptoms and signs referable to massive leukemic involvement of organs other than those already discussed. Fourteen masses in all were irradiated, with good results in 9. Daily doses of 25 to 200 r (air) were given to local areas, with total depth doses ranging from 16 to 900 r. The effective depth dose was again found to be about 450 r.

The authors feel, on the basis of their experience, that roentgen therapy of local areas in small dosage for the control of symptoms due to leukemia has proved to be of distinct benefit. This modality should be employed in conjunction with antileukemic chemotherapy.

Four photomicrographs; 5 photographs; 8 tables.

R. S. BASILI, M.D.
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**Combined Radiation and Nitrogen Mustard Therapy in Hodgkin's Disease as Compared with Radiation Therapy Alone.** James C. Cook, Kenneth L. Krabbenhoft, and T. Leucutia. Am. J. Roentgenol. **82**: 651–657, October 1959. (Harper Hospital, Detroit 1, Mich.)

The aim of therapy in Hodgkin's disease is to obtain the greatest palliative relief as well as to produce prolonged patient survival. Nitrogen mustard has been used chiefly as an alternative after resistance to roentgen therapy has developed. This report is concerned with simultaneous administration of nitrogen mustard and radiation from the outset of the disease.

Three hundred and forty-seven patients with Hodgkin's disease (both localized and generalized) were suitable for long-term follow-up study. The absolute five-year survival for this group was 34.6 per cent. No significant relationship between the course of the disease and the age and sex of the patient was shown.

A special group of 212 of these cases is analyzed in greater detail. X-ray therapy alone was given to 110 cases with a five-year survival of 37.2 per cent. When x-ray therapy was given in conjunction with nitrogen mustard in 102 cases, there was a 39.2 per cent five-year survival. When this same group of 212 patients is analyzed with respect to three-year results, roentgen therapy is found to have produced 45.3 per cent survival, while the combination of roentgen therapy and nitrogen mustard yielded 49.4 per cent. This improvement in palliation is supported by the fact that the average survival of patients expiring within the five-year period was 5.6 months longer for patients receiving the combined therapy.

There is also evidence to indicate that the combined method of treatment lowers the first year rate of mortality as well as producing further remissions in recurrent Hodgkin's disease. Both x-ray therapy and nitrogen mustard were administered according to the usual procedures and dosages.

Eight tables. RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

**Impressions of the Value of Megavoltage Irradiation in the Treatment of Malignant Neoplasia.** William Woods. M. J. Australia **2**: 665–668, Nov. 7, 1959. (Adelaide, South Australia)

This article is a general comparison of the effects of radiation produced by cobalt-60 units and linear accelerators as compared to the conventional deep x-ray therapy in the range of 200 to 400 kv. The well known physical advantages of megavoltage are cited. The author is also of the belief that some types of tumors respond to megavoltage radiation when experience has shown that they are resistant to conventional x-rays. No significant improvement with respect to cure has been effected in the following conditions: malignant melanoma, gastrointestinal carcinoma, lung carcinoma, tumors of lymphoid tissue, most sarcomas, most brain tumors except medulloblastoma and pituitary tumors, ovarian tumors, prostatic tumors, and pancreatic tumors. It is the author's opinion that any radiosensitive carcinoma in the head and neck from the base of the skull to the clavicles should be treated by radiotherapy in the first instance. Surgery should be reserved to deal with residuum, recurrence, or operable lymph nodes as a second line of attack. Other conditions which appear to show an improved response to megavoltage therapy are tumors of the bladder and bone and carcinoma of the cervix.

WYNTON H. CARROLL, M.D.
Shreveport, La.

**Megavoltage Radiotherapy.** W. P. Holman and J. H. Martin. M. J. Australia **2**: 668–670, Nov. 7, 1959. (Peter MacCallum Clinic, Melbourne, Australia)

This paper is an excellent presentation of why megavoltage equipment is an essential part of any good radiotherapy department and a discussion of the factors which govern the type and energy of the equipment to be selected. It is concluded that the linear accelerator, at an energy of 4 Mev, represents perhaps the optimum type of unit for a large institution. Its main disadvantage, however, is that it is a complicated piece of equipment which requires regular maintenance. Simpler maintenance, together with the low capital investment involved, makes certain cobalt teletherapy units attractive investments for centers serving smaller populations. An analysis of the relative merits of various types of generators is also presented.

Five graphs; 1 table.

WYNTON H. CARROLL, M.D.
Shreveport, La.

## RADIOISOTOPES

**Treatment of Pleural and Peritoneal Effusion with Intracavitary Colloidal Radiogold ($Au^{198}$).** Jerzy Dybicki, Oscar J. Balchum, and George R. Meneely. Arch. Int. Med. **104**: 802–815, November 1959. (G. R. M., Vanderbilt University Hospital, Nashville 5, Tenn.)

Since 1955, 45 patients with pleural and peritoneal effusions due to local or metastatic cancer have been treated by the intracavitary instillation of radiogold at the Radioisotope Center, Vanderbilt University (Nashville, Tenn.). Complete follow-up studies with regard to fluid accumulation after therapy were available in 39 patients. Two of the other 6 patients were given radiogold prophylactically before fluid had accumulated, and 4 died too soon after administration of $Au^{198}$ to permit evaluation.

Twenty-two of the 39 patients had a complete cessation of fluid formation (56.4 per cent), 7 had a definite

decrease in the accumulation of fluid (17.9 per cent), and in 10 patients (25.7 per cent) no change was observed. Good results were obtained in 12 of the 22 patients with pleural effusion and fair results in 4; treatment was considered a failure in the remaining 6. Ten of the 17 patients with peritoneal effusion obtained a good result and 3 a fair result; there was failure of fluid control in the remaining 4 cases.

A review of 1,899 cases of malignant pleural and peritoneal effusion treated by radiogold, recorded in the literature, indicates that good results were achieved in 50 per cent.

No complications of note were observed in the authors' series. About 20 per cent of the patients had a slight elevation of temperature. In 6 patients there was an insignificant decrease in the white cell count for three weeks; prolonged serial studies were impossible. When used properly, the administration of $Au^{198}$ presents no real hazard to patient or personnel.

Although only palliative and not curative, intracavitary $Au^{198}$ can successfully alleviate the distressing consequences of protein and electrolyte loss in patients with malignant effusions and can produce distinct symptomatic relief.

Seven tables.

**Treatment of Hemangiomas in Children with Strontium 90.** E. Frey. Radiol. clin. **28:** 399–404, November 1959. (In German) (Radiotherapeutische Klinik der Universität, Zurich, Switzerland)

Flat hemangiomas in children were treated with surface applicators containing 50 mc of strontium 90, filtered by 0.1 mm. of nickel. Strontium 90 has a half-life of twenty-eight years, emits a beta particle of 0.54 Mev (which does not penetrate the filter) to become yttrium 90, which has a half-life of 2.6 days and emits a beta particle of 2.2 Mev, which penetrates the filter. Inactive zirconium 90 is the final stage of the decay process.

The maximum penetration of the active radiation is 8 mm., with 3 to 4 mm. representing the therapeutically useful depth; thus centers of bone growth and the gonads are spared.

Single doses of 1,000 rads and total doses of 4,000 rads have been used with excellent curative and cosmetic results to date.

Four figures; 1 table.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

**Elevated Thyroidal $I^{131}$ Uptake in the Absence of Goiter in Isolated Venezuelan Indians.** Marcel Roche. J. Clin. Endocrinol. **19:** 1440–1445, November 1959. (Instituto venezolano de investigaciones cientificas, Caracas, Venezuela)

The 24-hour thyroidal uptake of $I^{131}$ was measured in 53 well nourished Indians from the Alto Ventuari region, Amazonas Territory, Venezuela. These Indians had had little or no contact with white men and, with 1 exception, their thyroids were either nonpalpable or normal in size. The average $I^{131}$ uptake was 70.8 per cent of the administered dose; 45 of the cases had uptakes of more than 50 per cent of the dose.

The average iodine uptake in this group was similar to that obtained earlier in Bailadores in the Venezuelan Andes (J. Clin. Endocrinol. **17:** 99, 1957. Abst. in Radiology **70:** 459, 1958).

If we admit the relatively small sample studied as being representative of the larger, widely scattered, sparse Indian population of the same region, the present results suggest that a high thyroidal avidity for iodine may exist in a general population, without goiter. Again, if we assume high thyroidal avidity to be a sign of iodine deficiency, we might conclude that such lack of iodine can be present without giving rise to endemic goiter. Iodine deficiency in these Indians may not be profound enough to produce goiter; this is unlikely, however, since in other regions where the average iodine uptake is distinctly smaller, goiter is prevalent. On the other hand, it may be that, in the human being, iodine deficiency is a necessary but not a sufficient cause of endemic goiter.

Four figures; 1 table. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

**Defect of the Iodinating System in Congenital Goitrous Cretinism: Report of a Case with Biochemical Studies.** Heskel M. Haddad and J. B. Sidbury, Jr. J. Clin. Endocrinol. **19:** 1446–1457, November 1959. (H. M. H., National Heart Institute, Bethesda 14, Md.)

The authors made a careful study of a boy of fifteen and a half years with goitrous cretinism. In such cases the function of the thyroid for forming biologically active hormone is impaired. In this instance the thyroid gland concentrated $I^{131}$ well but released the accumulated isotope following oral administration of thiocyanate. A study of the gland was undertaken in the hope of being able to locate the site of the defect by the demonstration of iodination in the thyroid homogenate when a system which slowly generated $H_2O$ was added. But, while stimulation of iodination in normal thyroid glands could be obtained by this means, no iodination could be shown in the homogenate in this case.

Three possibilities are considered to account for the abnormal mechanism: (1) an iodinase defect; (2) defective formation of "active" iodide, or (3) an abnormal receptor protein (thyroglobulin). The first of these is believed to be the most likely.

The authors use this case report as the basis of a good dissertation on the iodinating mechanism. An excellent summary of the literature is included.

Five figures. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

**Radioisotopic Study of Effects of Irrigating Fluid in Transurethral Prostatectomy.** Eldon M. Fillman, Otto L. Hanson, and Lael O. Gilbert. J.A.M.A. **171:** 1488–1492, Nov. 14, 1959. (109 W. Ninth St., Topeka, Kans.)

The authors describe their attempt to measure fluid absorption, hemolysis, and blood loss in the average transurethral prostatectomy in which irrigating fluid is used to distend the prostatic urethra and to wash blood and dissected tissue away from the operative site. Particularly they wished to determine whether enough fluid could be absorbed to threaten cardiac strain or produce circulatory embarrassment.

Absorption of irrigating fluid was determined by mixing small amounts of radio-iodinated human serum albumin with the irrigant and then comparing the total radioactivity in the circulating blood at the end of the operation with that in a given volume of the fluid. Hemolysis (which might be expected to follow use of sterile distilled water as the irrigant) was measured by tagging red blood cells with sodium radiochromate ($Cr^{51}$). By comparing total gain in radioactivity in the

circulating plasma at intervals during the operation with the radioactivity in a given volume of packed red blood cells taken from the patient, the amount of hemolysis could be calculated. Blood volume and hematocrit data were also obtained and were frequently of benefit. Details of the calculations are presented in the article. Reasonably accurate determination of blood loss could be determined during the operation by collection of irrigating fluid from the patient whose red blood cells had been tagged with radioactive chromate several days previously. With suitable calculations, based on total radioactivity in the fluid and in the red blood cells, and knowledge of hematocrit, the calculated blood loss can be derived. Possible sources of error are discussed.

In 7 of 11 cases investigated for fluid absorption, the calculated intravascular addition measured less than 110 c.c. In only one instance was a large amount of fluid (1,780 c.c.) absorbed, and in this case operative features were believed to be responsible.

The highest figure for hemolysis was 44 c.c. in a patient who exhibited no ill effects. In all other instances, hemoglobinemia secondary to hemolysis of volumes less than 16 c.c. would appear to be of no clinical significance. In this experiment, blood loss ranged from 55 to 500 c.c. but averaged less than 280 c.c.

Conclusions are that fluid absorption resulting from irrigation at transurethral prostatectomy is not excessive if a low hydrostatic fluid pressure is used and if the dissection is not carried into venous sinuses surrounding the prostatic capsule. Likewise hemolysis resulting from the use of sterile distilled water is not a serious problem. Distilled water is a safe irrigating medium if used as above. It was not felt that iso-osmotic solution adds to the difficulty of resection and it has the one great advantage of reducing toxicity in the event of perforation of the surgical capsule and large fluid absorption into the patient's vascular system.

Two tables. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**The Proliferation Dynamics of Blood Cell Formation, Autoradiographically Examined with Tritium-Labeled Thymidine.** T. M. Fliedner, E. P. Cronkite, and V. P. Bond. Schweiz. med. Wchnschr. **89:** 1061–1068, Oct. 10, 1959. (In German) (E. P. C., Brookhaven National Laboratory, Upton, N. Y.)

It was found possible to study blood-cell formation autoradiographically with the aid of radioactive thymidine. Tritium($H^3$)-labeled thymidine is incorporated *in vivo* and *in vitro* into DNA of cells during the period of DNA synthesis. This label is stable and unexchangeable and can be demonstrated by means of high resolution stripping-film autoradiography.

Serial bone-marrow and blood samples were taken after intravenous injection of $H^3$-thymidine in a patient with undisturbed hematopoiesis. The appearance and disappearance of the label in blood-cell precursors and blood cells was used to determine the turnover of hematopoietic tissues. The average generation time in the erythropoietic series was found to be about nineteen hours, and in the myelocytic series about forty to fifty hours. After *in vitro* incubation of marrow cells and blood cells with $H^3$-thymidine for one hour, all cells in DNA synthesis at the time of sampling are labeled. This presumably indicates their potentiality for further cell division and thus provides a measure for the proliferative potentials of the cell type studied. In the peripheral blood of healthy persons small numbers of DNA-synthesizing cells are present. Thymidine labeling both *in vivo* and *in vitro* is a useful means of studying the dynamics and potentials of blood-cell formation under normal conditions and in disease; it may lead to a better understanding of disturbances of blood-cell formation.

Nine figures.

**Radiochromium in Determination of Blood Volume Changes.** G. K. Daikos and D. A. Koutras. Schweiz. med. Wchnschr. **89:** 1108–1111, Oct. 17, 1959. (In German) (Therapeutische Universitätsklinik, Athens, Greece)

Comparative studies of the values of blood volume as measured by Evans blue, polyvinyl pyrrolidone, and $Cr^{51}$-tagged red cells are described. The determinations were carried out simultaneously in the same patients and with the same samples of blood. No interference of one test substance with another was detected. The fate of each test material was investigated. The $Cr^{51}$-tagged red cells did not show any appreciable change in the twenty-four-hour observation period. The Evans blue dye decreased on the average to 45 per cent of the original amount injected; the polyvinyl pyrrolidone decreased even more—to 23 per cent. The fact that there was no change in the radiochromium permitted repeated blood volume determinations with a single injection of tagged red cells. With the other technics, a new injection of the test substance was necessary. The superiority of the radiochromate method is discussed.

One figure; 5 tables.

**Experimental Intralaryngeal Injection of Radioisotopes.** Joel J. Pressman, Andrew H. Dowdy, Raymond L. Libby, Max Fields, Mildred B. Simon, and Kathryn Hand. Arch. Otolaryng. **70:** 459–465, October 1959. (U.C.L.A. Medical Center, Los Angeles 24, Calif.)

This report is concerned with the experimental injection of $CrP^{32}O_4$ and $Cr^{51}P^{32}O_4$ into the submucosal spaces of the larynx. Observations were made of the local effects of the radiation from $P^{32}$ on the larynx and the distribution of $CrP^{32}O_4$within this organ. The authors believe that these experiments have expanded our knowledge of the anatomy and physiology of the larynx and have proved helpful in understanding the natural history of certain laryngeal diseases. The clinical applications of the findings are discussed. The importance of bearing these in mind in relation to surgery of the larynx can hardly be overestimated. On their basis one can almost venture to predict the route of spread of laryngeal tumors. It was likewise established that intralaryngeally injected isotopes remain within specific areas of the larynx long enough and in sufficient dosage to be considered of possible therapeutic value.

Five figures, including 2 roentgenograms.

**Effect of Triton on Triolein $I^{131}$ Distribution in Atherosclerotic Rabbit Tissues.** Sanford O. Byers, Paxton Cady, Meyer Friedman, and Leland Felton. Am. J. Physiol. **197:** 1053–1055, November 1959. (Mount Zion Hospital and Medical Center, San Francisco, Calif.)

In an earlier study (Felton *et al.*: Am. J. Physiol. **197:** 351, 1959. Abst. in Radiology **75:** 338, 1960), the authors found that atherosclerotic aortic tissue in the rabbit appeared to absorb twice as much $I^{131}$ after in-

travenous injection of triolein $I^{131}$ as did normal tissue, when examined ten minutes after the fat injection, while at twenty-four hours practically no radioactivity remained in either normal or atherosclerotic tissue. In the present investigation preliminary injection of triton, which has been shown to retard the escape of triglycerides from the plasma (Am. J. Physiol. **190:** 439, 1957), was found to increase this differential half again and probably prolonged the time in which it may be demonstrated, so that atherosclerotic aortic tissue contains about three times as much radioactivity, on a weight basis, as does normal aortic tissue, even though the animals were sacrificed after twenty-four hours. Presumably this increased differential (as compared with the earlier study) results from the sustained high concentration of tracer in plasma and the prolonged contact with the aortic intima which is brought about by triton.

**Myocardial Extraction of $Rb^{86}$ in the Rabbit.** Robert E. Mack, David D. Nolting, Charles E. Hogancamp, and Richard J. Bing. Am. J. Physiol. **197:** 1175–1177, December 1959. (St. Louis VA Hospital, St. Louis, Mo.)

In 1957 (J. Clin. Invest. **36:** 468, 1957), Love and Burch suggested a method for the determination of coronary blood flow based upon the myocardial uptake of $Rb^{86}$. The principal requirements of this method are (1) a radiation detector which can quantitatively determine the myocardial $Rb^{86}$ in the intact subject, and (2) an average value for myocardial $RB^{86}$ extraction from arterial blood which will be constant from subject to subject at a variety of coronary blood flow rates. By this means coronary catheterization can be avoided and flow may be calculated as: $\text{Flow} = U/(\text{T} \times A)$, where $U$ is the net myocardial $Rb^{86}$ uptake per unit time, T is the average percentage myocardial $Rb^{86}$ extraction, and $A$ is the mean arterial $Rb^{86}$ concentration during the experimental period.

For their investigations of the myocardial extraction of $Rb^{86}$, the authors used the Langendorff preparation in the isolated rabbit heart. Extraction was found to be related exponentially to both the rate of flow and the length of time of the flow. The data in these experiments suggest that when coronary blood flow is increased or decreased 50 per cent, the error which results from assuming a constant value for myocardial extraction is of the order of 20 per cent.

Four figures; 1 table.

**Liver Function in Regenerating Rat Liver. $CrPO_4$ Colloid Uptake and Bile Flow.** George F. Leong, Rita L. Pessotti, and Ralph W. Brauer. Am. J. Physiol. **197:** 880–886, October 1959. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Functional changes in the regenerating hepatic tissue as indicated by $CrPO_4$ colloid extraction and bile secretion by an isolated rat liver preparation were studied by the authors. Following partial hepatectomy, the liver weight/body weight ratio of the operated rats was significantly lower than that of the nonoperated controls. This is attributed to only an 80–85 per cent restoration of the residual hepatic tissue. A transient increase in bile secretion/unit weight of liver by 50 per cent above the preoperative level occurred within forty-eight hours after partial resection. The uptake of radioactive chromic phosphate colloid indicated an increase in Kupffer cell activity (phagocytic functions) to values 200 per cent above control within forty-eight hours. This function was sustained and remained elevated for at least ninety to one hundred days postoperatively. Histologic evidence suggests that the increased Kupffer cell activity is probably due to an increase in phagocytic cell population. Theoretical considerations for these changes in specific function of regenerating hepatic tissue and their relation to normal resting liver are discussed.

Five figures; 2 tables.

## RADIATION EFFECTS—PROTECTION

**Human Exposure to Radiation.** Karl Z. Morgan. Bull. Atomic Scientists **15:** 384–389, November 1959. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.)

All radiologists should read this paper for its summary of popular scientific thought on radiation exposure to man. It is a nicely done, well presented collection of material with a group of useful figures brought together in one place. Tables are included showing the permissible genetic dose to the population at large, as suggested by the International Commission on Radiological Protection; exposures involved in common diagnostic and therapeutic roentgen procedures and in shoe-fitting fluoroscopy; and the permissible absorbed dose to various organs from internal emitters. [In the Table on permissible genetic dose, the figure 4.5 rem for the average medical dosage is probably too high by a factor of 5 for the total population of the country; it may represent the high usage levels of large city medical centers. See Brown, Heslep, and Eads: Radiology **74:** 353, 1960.—S. F. T.]

Two figures; 4 tables.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

**Incidence of Neoplasia After Irradiation of Thymic Region.** Howard B. Latourette and Fred J. Hodges. Am. J. Roentgenol. **82:** 667–677, October 1959. (University Hospital, Ann Arbor, Mich.)

This report is concerned with the possibility that irradiation of the thymic region in infants and children might increase the likelihood of development of certain types of malignant disease. Follow-up information was available on 867 patients who received such irradiation between 1932 and 1951. The usual dosage was 200 r (air dose) given once. The maximum dose given at any one time was 320 r. The most commonly used factors were: 150 kv, 50 cm. target-skin distance, 0.25 mm. Cu + 1.0 mm. Al filtration, h.v.l. 1.0 mm. Cu, field size 10 × 10 cm. Ninety-nine patients had died. Of this group, 2 had lymphoblastoma, 1 leukemia, and 1 lymphosarcoma.

Since a comparable study of a control group is impossible, vital statistics rates, age distribution of the study population, and the time of observation were used in determining the relative incidence of neoplasia following thymic irradiation. Lymphoblastoma occurred more frequently than expected, but not significantly so. The incidence of carcinoma of the thyroid gland

(1 case) was significantly higher than might be expected. Comparison with other reported statistics suggests a direct correlation between dosage to the thymic region and the incidence of thyroid carcinoma. Some bone lesions arose in the irradiated area, but there is insufficient information to determine the relative incidence. The number of cases of leukemia and lymphosarcoma was no higher than expected.

The authors conclude that these findings are additional suggestive evidence of some increase in the incidence of neoplasia after irradiation of the thymic region.

One graph; 13 tables.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

**Ocular Effects of Radiation.** David G. Cogan. Arch. Indust. Health **20:** 293–296, October 1959. (243 Charles St., Boston 14, Mass.)

This paper was given before the American Academy of Occupational Medicine in February 1959 and is of a rather general nature. After calling attention to some of the anatomic and physiologic features of the eye which make it especially vulnerable to radiation, the author discusses the various types of radiation, from radiodiathermy to ionizing radiations, and the damage which these may produce. Much of the material in the section on ionizing radiations has appeared in RADIOLOGY, either in the original or abstract form.

**Chronic Radiation Nephritis: A Review of the Literature with Report of a Case.** James A. Jernigan. Ann. Int. Med. **51:** 1084–1092, November 1959. (Aviation Medicine Clinic, Washington 25, D. C.)

The impression that renal tissue is markedly insensitive to radiation damage is probably erroneous; and it has been shown that when 2,300 r or more is delivered to the kidney in less than five weeks, radiation nephritis can be expected in from six to eighteen months.

The basic process is essentially as follows: Ionization in the tissues causes molecular changes, altering cell metabolism, and this leads to histopathologic changes. Early hyperemia is followed by swelling and desquamation of tubules. Marked tubular degeneration develops, and later there are hyalinization of glomeruli and interstitial fibrosis. Finally, endarteritis occurs, up to twelve months after the irradiation. Symptoms of nephritis ensue; with hypertension, proteinuria, and elevated blood urea nitrogen. In unilateral radiation nephritis, cures have been reported after nephrectomy.

The condition is described in a 39-year-old woman who had pseudomucinous ovarian cystadenoma with multiple intraperitoneal implants. A tumor dose of 3,000 r was given in sixty days through multiple wide anterior and posterior abdominal ports. Factors were 250 kvp and 0.5 mm. copper filtration. Seven months after irradiation the signs and symptoms of nephritis occurred. Therapy consisted of low-salt diet, digitalis, reserpine, hydralazine hydrochloride, packed red cell transfusions, chloropromazine, and prednisone. The patient was well and the disease apparently controlled twenty-five months after therapy.

Further study of the prevention of radiation nephritis is necessary to avoid this complication of treatment; and the therapeutic or prophylactic benefit of steroids, antitensives and other drugs remains to be decided by experimental and clinical observations.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Management of Advanced Radiation Proctitis.** Irving F. Chanin and Jack W. McElwain. Ann. Surg. **150:** 890-894, November 1959. (Amityville, N. Y.)

Radiation or factitial proctitis is most common after irradiation of tumors of the corpus or cervix but occasionally is encountered following treatment of disease of the bladder or prostate. It is classified into four grades, depending on severity. Faulty radium application is incriminated as the primary contributing factor.

Grades I and II may usually be treated conservatively, although persistent, progressive pain, hemorrhage requiring repeated transfusions, and uncontrolled diarrhea or tenesmus may occasionally represent Grade II disease requiring colostomy. Conservative measures include high-caloric, low residue diets, stool softeners, rectal olive oil or mineral oil installations, and warm sitz baths. When spotty ulcerations occur, rectally instilled Furacin solution, Streptokinase-Streptodornase, and topical hydrocortisone are useful.

Rectal stricture complicating proctitis and ulceration is classed as a Grade III lesion. Grade IV lesions are those with bowel perforation or rectovaginal fistula superimposed on a Grade III process. The initial operation in these cases is diversion of the fecal stream by colostomy, though there may be some lesions of Grade III in which gentle, gradual dilatation of the stricture will be sufficient. Further surgery, whether resection of the involved segment of bowel or reanastomosis, should not be performed until eighteen to twenty-four months post-colostomy lest Grade IV lesions complicate treatment.

Five cases are reported.

WENDELL M. BURNS, M.D.
Covina, Calif.

**Prochlorperazine and Irradiation Sickness.** M. J. Solan. Brit. M. J. **2:** 1068–1069, Nov. 21, 1959. (St. Thomas's Hospital, London, England)

Fifty-seven patients who were receiving therapeutic irradiation and were expected to suffer side-effects were the subjects of a controlled comparison test of prochlorperazine, pyridoxine, and a placebo. The drugs were administered three times daily before meals. Total daily dosage was 30 mg. of prochlorperazine and 60 mg. of pyridoxine. Only the pharmacist knew which tablets each patient was taking.

The results demonstrated a clear superiority of prochlorperazine in the relief of irradiation sickness and, interestingly enough, showed that there was only a small difference in favor of pyridoxine over the placebo. Side effects were minimal with the dosages used.

Two tables. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Subacute and Late Cardiovascular Sequelae to Low Doses of Gamma Radiation.** Durwood J. Smith, Robert G. Parker, Calvin Hanna, and Henry E. Curley. Am. J. Physiol. **197:** 725–729, October 1959. (College of Medicine, University of Vermont, Burlington, Vt.)

A battery of *in vivo* and in *vitro* tests were employed to assess the effects of whole-body gamma ($Co^{60}$) radiation upon the cardiovascular system of dogs. Pressure-volume curves of isolated surviving blood vessels were selected as the most practical measure of variations in the physical properties of arteries, and a new method for such studies is described.

Groups of 6 beagles were exposed to 30 r and 100 r twenty-two months before death and compared with

littermate controls. No differences between irradiated and control dogs could be detected. Eight mongrel dogs received 300 r thirty days before death and were compared with 5 mongrel controls. The only significant difference observed was in the pressure-volume curves of arteries. It is concluded that 30 r and 100 r of whole-body gamma radiation have no demonstrable effect upon the cardiovascular system of dogs irradiated twenty-two months before study, but that 300 r does produce a significant abnormality of the blood vessels.

Three figures; 1 table.

**Environmental Hazards Associated with the Milling of Uranium Ore. A Summary Report.** W. B. Harris, A. J. Breslin, H. Glauberman, and M. S. Weinstein. Arch. Indust. Health **20:** 365–382, November 1959. (New York Operations Office, U. S. Atomic Energy Commission, 376 Hudson St., New York 14, N. Y.)

Among the most important industries involved in the handling and processing of radioactive materials, the mining and milling of uranium ore presents one of the most important potential hazards to a very large industrial population. The basic objectives of the study which is reported here were (1) to evaluate the extent of the hazard to personnel working within the uranium milling plant from the various materials of interest; (2) to determine the efficacy of control measures which have been installed to provide reasonable guidance to the mill operators in resolving health problems which still exist; (3) to determine environmental contamination which might result from the process; (4) to determine the efficacy of environmental control procedures for the guidance of other operators; (5) to establish the proportion of hazard arising from individual isotopic components and, if possible, to devise a procedure for ready evaluation which may be followed by the operators and trusted by the enforcement agencies, and (6) to determine the extent of exposure arising from each part of the plant so as to emphasize those areas which require improved control.

Tables are reproduced giving the daily average exposure to $\alpha$-emitting dust, weighted average exposure, average daily exposure by areas, average general air concentrations by area, typical breathing zone concentrations, and the uranium excretion rate. Other potential hazards, *e.g.*, silica dust inhalation, are discussed. Suggestions are made for reducing occupational exposures.

Four charts; 16 tables.

**The Industrial Code as a Tool in Radiation Protection.** Morris Kleinfeld and Melvin M. Udel. Arch. Indust. Health **20:** 199–201, September 1959. (400 Ocean Parkway, Brooklyn, N. Y.)

An industrial code can be a valuable tool in radiation protection. New York State Industrial Code Rule No. 38, Radiation Protection, has proved very effective, and 6 other states have promulgated similar codes. It provides for the registration of all industrial sources of ionizing radiation and places responsibility for control on management. It defines the areas of jurisdiction of the Health and Labor Departments. It establishes criteria for safe operation in terms of maximum permissible exposures and procedures such as surveying, monitoring, labeling of radiation sources, record keeping, and the instruction of personnel in proper work technics. It also requires the assignment of qualified radiation safety personnel to supervise the use of ionizing radiation.

There are important aspects of radiation protection with which a code cannot deal effectively. However well written and well administered a code may be, accidents due to human failure cannot be entirely prevented. Accidents will inevitably occur if, either through ignorance or carelessness, the provisions of the code are ignored or circumvented. Surveys, monitoring, and other procedures required by a code can be no better than the people who perform them. A code cannot by itself assure a safe installation. It does not provide the know-how that comes only with training and experience, and it is not a substitute for a continuing and intelligent vigilance. The New York Code requires reporting of excessive exposure to personnel and of the corrective measures that were taken but does not define what constitutes radiation injury or its reporting to the appropriate agency. The authors do not believe that it is within the purview of a radiation protection code to deal with such matters as radiation injury, liability, and disability, all of which belong to the field of compensation medicine. In essence, the Code is a safety measure designed to protect the worker against undue exposure from ionizing radiation.

The National Committee on Radiation Protection has drafted a model state code, which is contained in the National Bureau of Standards *Handbook 61.*

**Emergency Respiratory Protection Against Radiological and Biological Aerosols.** H. Gerald Guyton, Herbert M. Decker, and George T. Anton. Arch. Indust. Health **20:** 91–95, August 1959. (Biological Warfare Laboratories, Fort Detrick, Md.)

Tests were performed on 18 variations of 8 common household and personal items to determine their value as respiratory protective expedients in the event of radiological or biological attack. The items selected for the investigation were: man's cotton handkerchief, woman's cotton handkerchief, cotton dress material, muslin bed sheet, man's cotton shirt, rayon slip, Turkish bath towel, and toilet paper. These items were evaluated on human subjects in an exposure chamber where a biological aerosol of harmless bacterial spores was generated to simulate an aerosol of radioactive dust.

Five variations of these items were found to have a filtration efficiency greater than 85 per cent: a man's cotton handkerchief folded to a thickness of 16 layers, folded to a thickness of 8 layers, or placed over the mouth in a crumpled state; a commercially available toilet paper, when used in a thickness of three sheets; a bath towel, when folded in two layers. However, the high resistance to breathing produced by the handkerchief folded to give 16 layers, or crumpled, limits the employment of these two variations to short intervals.

In order to determine if wet items were superior to dry items, 5 of the cloth materials were evaluated after being saturated with water and subsequently hand-wrung. The most efficient of these items was the bath towel (70.2 per cent). This result is less than obtained for 7 dry items. Four of the 5 wet items produced extremely high resistance to breathing; their use as respiratory protective expedients therefore appears impractical.

Four figures; 2 tables.